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# **Primary Science in Malaysia: The Implementation of a New Curriculum**

**By**

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**A thesis submitted for the degree of Doctor of Philosophy in Education  
of the University of Warwick**

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## **Abstract**

**This thesis investigates the implementation of the science curriculum in Malaysian primary schools. The study is concerned primarily with teachers' pedagogical content knowledge as a crucial determinant of teaching performance in implementing the new curriculum.**

**The research involved the administration of a questionnaire to seven states in Malaysia to seek information regarding the implementation of the primary science curriculum. The main body of research data consists of case studies of 14 teachers. Teachers' pedagogical content knowledge and its influences on the implementation of the primary science curriculum were analysed on the basis of interviews and classroom observations.**

**The lack of science pedagogical content knowledge is indeed a problem for teachers in implementing the curriculum. That knowledge is limited and constrained by other contributing factors — science instructional needs, especially the constructivist view of science teaching; knowledge of the ways in which children learn science; and the lack of resources and support. Teachers' belief in the subject and its teaching also effect the implementation. In the light of these constraints, it would be more appropriate to identify the necessary science pedagogical content knowledge, within the primary science curriculum, that teachers need to acquire in order to implement the curriculum as the developers intended.**

**The key question, in the Malaysian primary school context, is how science pedagogical content knowledge is to be generated and disseminated. In-service teacher education is essential if there is to be an impact in the shorter term. Another question is the kind of initial training that will be fruitful and effective and worth investing in. Conceptual understanding and science pedagogical knowledge and skills are two promising areas of teachers' understanding of the curriculum that could be developed when planning in-service provision for Malaysian primary science education. An explicit examination to teachers' beliefs about science and the teaching and learning of science is also required in pre-service and in-service courses.**

## Glossary of Terms and Abbreviations

CCC	Central Curriculum Committee
CDC	Curriculum Development Centre
DES	Department of Education and Science
DfE	Department for Education
DfEE	Department for Education and Employment
EPRD	Educational Planning and Research Division
GRIDS	Guideline for Review and Internal Developments in School
GTP	Graduate Teacher Programme
HMI	Her Majesty's Inspector
ITT	Initial Teacher Training
KBSM	Kurikulum Bersepadu Sekolah Menengah (Integrated Secondary School Curriculum)
KBSR	Kurikulum Baru Sekolah Rendah (New Primary School Curriculum)
KS	Key stages are the periods into which the years of compulsory schooling are divided for the purposes of teaching and assessing the National Curriculum. There are four key stages: Stage One - ages 5 -7 Stage Three - ages 11 - 14 Stage Two - ages 7 – 11 Stage Four - ages 14 - 16
LEA	Local Education Authority
MAE	Man and Environment
new KBSR	Kurikulum Bersepadu Sekolah Rendah (Integrated Primary School Curriculum)
OFSTED	Office for Standards in Education
PGCE	Post Graduate Certificate of Education
SATs	Standard Assessment Tasks/Tests are tasks which will be externally set and which pupils will take at the end of a key stage. Their purpose is to measure (in conjunction with teacher ratings) the achievement of pupils on the National Curriculum attainment targets.
SCITT	School-based Initial Teacher Training
TMP	Third Malaysian Development Plan
UPSR	Ujian Penilaian Sekolah Rendah (Primary School Assessment Test)



## **Chapter 1 INTRODUCTION: EDUCATION IN MALAYSIA**

### **1.1 Historical Perspective**

Malaysia is a multi-racial nation. About 55% of the population are Malay, 37% Chinese and 8% Indian. In order to maintain peace and harmony between the peoples, constant efforts have to be made by the central government to foster national consciousness among the various ethnic groups. Education plays a major role in this process. Hence, one of the objectives of education in Malaysia is to achieve national unity. Many dialects are spoken in Malaysia, but Bahasa Malaysia is the national language and the language of instruction in all public schools. Common curriculum content is also used in all the schools throughout Malaysia. It is hoped that by sharing common experiences greater cohesion among the diverse races will result.

Before Malaysia achieved independence in 1957, there were four different types of school with four languages of instruction: Malay, Chinese, Tamil and English. Each type of school had its own curriculum, which reflected the traditions from the pupils' country of origin. Hence, there existed separate and uncoordinated systems within education. When the nation achieved its independence, the leaders of the independence movement realised that steps had to be taken to integrate the multi-ethnic groups in order to achieve a common nationality. Hence, education played a vital role in effecting this change.

The Report of the Education Committee, also known as the Razak Report (1956), and the Report of the Education Review Committee (Rahman Talib Report 1960) formed the basis of national education policies and the Education Act of 1961. The



emphasis and recommendations of the committee brought about significant changes in the system of education over the next 20 years. The use of Bahasa Malaysia as the national language and as a medium of instruction, a common content curriculum syllabus, a common system of national assessment, and the provision of religious and moral instruction have been implemented and a single national system of education established.

The Razak Report (1956) stated that the committee's terms of reference in formulating recommendations for education policy in Malaysia were to:

*'.....establish a national system of education acceptable to the people of the Federation as a whole which will satisfy their needs and promote their cultural, social, economic and political development as a nation, having regard to the intention to make Malay the national language of the country whilst preserving and sustaining the growth of the language and culture of other communities living in the country.'* (Razak Report 1956, Para 1a)

This statement clearly implies that, even though the recommendations emphasised the use of the national language, the languages of other ethnic groups would still be maintained in order to avoid racial tension.

The recommendations were implemented in 1957, when the National Language was made a compulsory subject at all levels in all assisted primary and secondary schools (Ministry of Education 1971, p.37) and a gradual implementation of the National Language at other levels of the educational system began. Marsh and Morris (1991) support the decision to have one national language:

*'....., in multiethnic societies such as Singapore and Malaysia, the language of instruction can be used as the vital tool for inculcating a cohesive national identity and for facilitating a cohesive national identity and for facilitating communication between ethnic groups'. (p.267)*

Though there were obstacles and problems in implementing the National Language in multi-racial Malaysia, it did achieve its objective. The younger generation that went through this educational system can now communicate in one language,

thereby ensuring that there is no barrier to effective interaction. This has greatly reduced the misunderstandings that can cause disharmony among ethnic groups. In general, the recommendation to promote unity through a common language has succeeded. However, despite all the developments that have taken place since 1957, an ethnic riot erupted in 1969 due to dissatisfaction among some ethnic groups with the ruling political party. Following this, a new economic policy was implemented, with education becoming one of the tools for not only achieving national unity but also for restructuring Malaysian society (Harris 1993). For example, the Third Malaysian Development Plan (TMP) of 1976 (cited in Adam and Chan, 1981) stated that the overall mandate for education's role was to realise the objectives of the New Economic Policy i.e. *national integration and unity*.

The TMP document outlines briefly the education goals for the next five years (ibid.)

*1333. The education and training objectives under TMP will be to: -*

- (i) strengthen the educational system for promoting national integration and unity through:*
  - (a) the continued implementation, in stages, of Bahasa Malaysia as the main medium of instruction at all levels;*
  - (b) the development of personality, character and good citizenship and the promotion of moral discipline through curriculum and extra-curriculum activities;*
  - (c) narrowing the gap in educational opportunities between the rich and poor and among the various regions and races in the country, through a more equitable distribution of resources and facilities;*
  - (d) the eventual integration of the educational system in Sabah and Serawak into the national system.*

(Cited in Adams and Chan 1981, p.141)

Therefore, the importance given to National Language as a fundamental requirement for promoting national unity continues to be recognised.

Another of the recommendations made for achieving unity concerned the common curriculum. The Razak Report (1956) recommended that:

*'one of the fundamental requirements of educational policy in the Federation of Malaya is to orientate all schools, primary and secondary, to a Malayan outlook. We consider that the way to do this is to ensure a common content in the syllabuses of all schools'. (Razak Report 1956, Para 115)*



The role of education in promoting unity in Malaysia was thus established through these two main recommendations. However, Harris (1993) argued that

*'The education system that emerged upon independence was a reflection of the accommodating and compromising spirit among the various ethnic groups of the country. Thus when the country achieved its independence in 1957, the plural school system which had been in existence since colonial times was retained. In fact the education system of the country reflects the plural nature of Malaysian society.'* (p.2)

If the aim of educational policy was to promote unity, then why, we must ask, do separate Chinese and Tamil schools still exist today? Is Malaysia still failing to promote unity through education? It might be argued that if Malaysia is really united, then we do not need the plural school system today, 42 years after independence.

What is clear is that after the first two decades of independence, the school system was just a tool to inculcate a shared Malaysian identity through a common language of instruction and common content syllabus.

However, it is worth reiterating that the common school curriculum has helped to achieve integration among the younger generation. For example, students discuss among themselves the same historical background of the nation. In fact, they discuss their homework or schoolwork together even though they are from different schools.

Where did science education feature in these developments? According to the TMP,

*'(ii) the orientation and expansion of the educational and training system towards meeting national manpower needs, especially in science and technology.'*

(Cited in Adams and Chan 1981, p.141)

This implies that the role of science education is vital in encouraging students to develop an interest in science and technology, thereby helping to ensure that the nation has sufficient manpower in these fields. As Adam and Chan (1981) observe:

*'....., economic development depends on the level and type of education provided. Devices are needed if the schools of the future are to create in abundance technicians, technologists, and professionals, scholars and administrators whose combined efforts will*



*coalesce to precipitate economic and social progress. By implication, much of the production will hinge on the nature, scope and content of school curricula.' (p.148)*

It is thus ironic that science education was not emphasised in the primary curriculum reform of 1983. The Report of the Cabinet Committee (1979) showed that in 1975 there was a shortage in the professional and semi-professional categories (when compared with 1985), especially in the areas of engineering, medicine and law. Even though the manpower data showed a shortage of professionals in science, the recommendations of the Cabinet Committee did not place any emphasis on science at the primary level. Instead science was taught to primary children as a small element within a combination of a number of subjects. There is clearly a strong case for arguing that, science education should have been made a major priority at the earliest possible level, i.e. in primary schools. Given the chance, the young generation at that time might have developed an interest in, and positive attitudes and aptitudes towards, science and technology. There might not have been any shortage of science manpower during the 1980s if the science curriculum had been given greater emphasis as a core subject from the early years of school onward.

Watson (1982) observes:

*'the Malaysian government was hoping to keep pace with the advanced nations of the world by pursuing science and mathematics reforms. The modified version of the Scottish Integrated Science Program and the Nuffield Science Projects have been introduced into Malaysian Secondary schools in the late 60's and early 70's .....The schemes were introduced quickly .....but due to external influences and constraints of these curricular development there has been too little real attempt to re-orientates science teaching along lines more suitable to the needs of rural people.' (p.105)*

This implies that however important the role of science education in a developing country, especially when the country is striving towards stable economic development, curriculum development, particularly in science education, must be undertaken correctly. A curriculum adopted from the United Kingdom, as Watson

(1982) observes, might not succeed in Malaysia, since it might not be suitable for pupils from different cultural background to that of the UK. If the science curriculum fails, this reflects on the curriculum developer, the teacher educator and teachers in school. When this happens, it is not surprising that there is a shortage of manpower in the scientific professions, and that the dropout rate from science increases.

Also when science education is emphasised in secondary schools without the pupils having studied any basic science in their primary schools, this might also cause a failure of science reform. When pupils are exposed and introduced to science as early as possible, this enhances their motivation and interest in science, and more of them will pursue science at a higher level and in their future careers.

## **1.2 Curriculum Innovation in Malaysia**

A major review of the national education policy was begun in 1974 and the Report of the Cabinet Committee was published in 1979. According to the latter report:

*'The curriculum at the primary level is in the form of general education and not basic education. General education is education in which the curriculum emphasises academic matters. Basic education is education in which the curriculum emphasises the acquisition of skills that can help children to function more effectively after completing education at the primary level.'* (p.11)

It is interesting to compare this statement with the UK White Paper *Better Schools* (cited in Emerson and Goddard, 1989), which suggested that the primary curriculum should:

- place substantial emphasis on achieving competence in the use of language
- place substantial emphasis on achieving competence in mathematics
- introduce pupils to science
- lay the foundation of understanding in religious education, history and geography, and the nature and values of British society
- introduce the pupils to a range of activities in the arts
- provide opportunities throughout the curriculum for craft and practical work leading up to some experience of design and technology and solving problems



- provide moral education, physical education and health education
- introduce pupils to the nature and use in school and in society of new technology
- give pupils some insights into the adult world, including how people earn their living

The White Papers (ibid.) recommendations for the primary curriculum emphasise the acquisition of more than a basic education in the 3 Rs (reading, writing and arithmetic), which are recommended by the Cabinet Committee for Malaysian primary education. Since Malaysia was a new developing nation seeking to ensure that the new generation was not illiterate, great emphasis was placed on the key skills, whereas the developed nations were at that time already entering the technological age. The statement made by the Cabinet Committee also meant that, if pupils possessed the basic skills, then they would be ready and able to further their education more effectively. The teacher's guidebook on the New Primary School Curriculum (Kurikulum Baru Sekolah Rendah, KBSR) (Ministry of Education 1983) stated that basic skills were to be taught in the first three years of primary school.

The New Primary Curriculum (KBSR) is divided into two phases. Phase I is for the first three years of primary education (Years 1-3, ages 7-9) and Phase II is for the last three years of primary education (Years 4-6, ages 10-12). The guide book states that Phase I should emphasise reading so that the pupils will be able to listen, speak, and identify and form letters and words, and apply these skills in writing. In the process of acquiring these skills, knowledge and concepts relating to Man and Environment are used as the context to aid the teaching of language. In the arithmetic skills, pupils are given basic skills such as counting, identification of numbers, and the use of the four basic mathematical operations: addition, subtraction, multiplication and division.



However, even though the basic skills, such as the 3 Rs, are important for primary pupils, these children should not be deprived of other knowledge. As we all know, children are exposed to the media, (including television, radio, computers and other modern devices), which have a major effect on their everyday experiences. The media give a lot of opportunities and exposure for children to learn science as everyday experiences. For example the programmes on television such as 'National Geographic', 'Animal Planet' and the like are able to educate children more in science. Therefore, children at the early phase of primary education should also be taught other subjects such as science, as recommended by the UK White Paper (ibid.).

Following the Cabinet Committee Report (1979), the whole primary curriculum was revamped. A number of reasons were cited for this change. The Committee found that among other things, *"The content of the primary school curriculum is overloaded for pupils ranging from six to twelve years old. Some pupils are not able to follow it, resulting in their mastery of only a few skills"* (para 193). The Committee also found that, *".....The curriculum has been formulated separately according to subject and there is little integration between the subjects in the curriculum."* (para 194). Based on these and other related findings, the Cabinet Committee recommended that:

*'(a) The Ministry of Education undertakes appropriate measures so that at the primary level there is a basic education with emphasis given to education in the 3R's, that is reading, writing and arithmetic;*

*(b) The curriculum for a basic education should also be considered from the viewpoint of the types of skills required rather than on the importance of each individual subject. These skills should be acquired through relevant areas of education concerned without reducing the present learning time.'*

(Cabinet Report 1979, Recommendation 2a)

Based on these findings and recommendations, the Ministry of Education announced that a new curriculum would be developed in accord with the Cabinet Committee Report. Despite the shortage for professionals in the science field, recommendation 2a (b) attached importance to skills and not to individual subjects; thus science was just a small element in an integrated subject called Man and Environment (MAE).

There are five themes to be taught in MAE. Science elements have to be included in all the five themes. For example; living things and characteristics of living things are taught under life processes for man, animals and plants theme.

### ***1.2.1 The new primary school curriculum (KBSR)***

The New Primary School Curriculum (Kurikulum Baru Sekolah Rendah, KBSR) was implemented nation-wide in 1983 and completed a full cycle in 1988 when the 1983 pupil cohort entered the sixth year of primary schooling. KBSR was implemented for the year 1 students who were six years old and not be more than 7 years old on 1 January of the school session of the year. This cohort was followed through until they were in Year 6 at 12 years of age. In 1989, the New Integrated Secondary School Curriculum (Kurikulum Baru Sekolah Menengah, KBSM) was ready for implementation at first-year (Form One) level.

KBSR stressed the importance of the overall development of the individual through the building of basic skills together with the promotion of co-operation and tolerance in accordance with the Malaysian educational philosophy. To achieve this, the KBSR program recommended that the teaching and learning strategies include:

- teaching with an integrated approach;
- using a variety of teaching methods with group teaching for same ability or mixed ability groups, class teaching and individual instruction;
- teachers are to provide a variety of learning experiences;
- teachers have 'flexibility' in the choice of content and in the use of teaching methods and aids;



- continuous evaluation is incorporated into the teaching and learning process;
- teachers are encouraged to provide an ‘informal’ classroom atmosphere with space to allow varied activities

(Noor Azmi 1991)

The design of the KBSR curriculum covers three domains: Communication, Man and Environment, and Individual Development. The total time allocated for instruction is 1320 minutes per week for Phase I and 1,440 minutes per week for Phase II plus breaks of 150 minutes. In Phase I, Language and Mathematics take 77.2% of available time per week, Music, Art Education and Physical Education take 11.4 % and Islamic Religious Education and Moral Education take 11.4% of time per week. In Phase II, Language and Mathematics take 64.6% of available time per week, Music, Art Education and Physical Education take 10.4% and Islamic Religious Education and Moral Education take 10.4%. Man and Environment takes 14.6% of the available time per week. The time allocation is greater for Phase II because of the extended knowledge that pupils must acquire. The design of the primary school curriculum is summarised in Table 1.0 below.

Domain	Component	Subject	
		Phase I	Phase II
Communication	Language	Medium of instruction National Language English	Medium of instruction National language English
	Mathematics	Mathematics	Mathematics
Man and Environment	Values, Attitudes and Spirituality	**Islamic Knowledge **Moral Education	**Islamic Knowledge **Moral Education
	Humanities and Environment	–	Man and Environment
Individual Self Development	Arts and Recreation	Music Art Education Physical Education	Music Art Education Physical Education

Table 1.0 The New Primary School Curriculum (KBSR)

\*\* When Muslim pupils and others who choose to study Islamic Religious Education are studying the subject, pupils of other religions will be required to study Moral Education. (Ministry of Education 1982).

As shown in Table 1.0, the communication domain is where KBSR emphasises the teaching of the three basics skills. It includes the component consisting of a single subject, Mathematics, and the Language Component, consisting of the National Language and English, which are taught in all National schools, and Chinese and Tamil, which are taught in the National-type schools. In the National Schools the medium of instruction is the Malay Language. In the National-Type Schools it is either Chinese or Tamil. In both types of school, the Malay Language is a compulsory subject. English is taught as a second language in all schools.

The second domain, Man and Environment, consists of two components: Values, Attitudes and Spirituality, which includes the Moral Education taught to non-Muslims while Muslim pupils are taught Islamic Religious Education. Islamic Religious Education emphasises guidance and training in the reading of the Quran and in the foundations of Islamic Religious Education, which includes Islamic *Aquidah* (i.e. *faith and belief*). Faith is the knowledge and belief (the Arabic word *Iman*) in the Unity of God, the prophethood of Muhammad (Peace be upon Him), belief in the day of Judgement, and life hereafter, and in the acceptance of the five-time prayers everyday and fasting in the month of *Ramadhan*. It is also means putting beliefs into practice by fulfilling one's obligations to both God and man. The pupils are taught this knowledge of *Iman* so that this faith will invariably lead them to a life of obedience and submission to the Will of God as good Muslims.

Moral Education aims to develop pupils of good character who can make responsible decisions based on the moral values of the individual, family, community and society. It seeks to enable pupils to practice habits and behaviour that are consistent with particular moral values and attitudes, and to make pupils



aware of the values existing in the society around them. In addition, Moral Education aims to equip pupils with moral values as the foundation for the development of mental maturity so that they can weigh matters based on moral principle before putting behaviour into practice. Lastly, Moral Education seeks to enable pupils to put forward rational reasons for making decisions pertaining to moral issues.

It is important for this domain to be taught in the primary curriculum in order ensure that the future generation possesses a strong faith in Islam and has good Moral values so that the nation will preserve the harmonious atmosphere in the country, thereby minimising social problems among the young. If good moral values, whether the Islamic or other, are instilled in the young generation, this will help them to judge whether their own behaviour is acceptable to the community and to understand the effect of their own behaviour on themselves. One issues is whether this domain does produce a good young generation with acceptable moral values in the community even though many young people are involved in drugs, drinking or illegal sexual activities. However, in Malaysia the Social and Welfare Department give these social problems a close attention. Therefore, this domain has contributed to the young generation's ability to weigh their decisions before indulging in immoral activities. The inclusion of this domain in the curriculum has helped the Social and Welfare Department reduce the social problems among the young. If teachers give this domain more emphasis, it might also help to maintain the prosperity, harmony and stability of the nation. Even though the Malays are taught Islamic values and the non-Malays are taught Moral education, the important thing is to actively propagate good values and expose the realities of life to children at an

earlier age. It is their values and culture rather than their ethnicity which influence the success or otherwise of any community (Mahathir 1993).

The Humanities and Environment domain consists of a single subject called Man and Environment. This subject is only taught at Phase II and is one of the important components of the KBSR curriculum. It integrates elements of science, history, geography, health education and civics and other areas of knowledge about Man and Environment. This subject, which is also known as the Knowledge Component, is taught from the beginning of Year 4 for pupils aged from ten years old.

The third domain consists of the Art and Recreation component, which is concerned with the development of the talents and interests of the pupils as well as with reinforcing basic skills. Authentic values and exercises are nurtured through three specific subjects in this domain: music, art education and physical education.

The curriculum design in KBSR, as mentioned earlier, extends over two phases.

Phase I, covers Years 1 to 3, emphasising mainly the mastery of the three basic skills, i.e. the 3 Rs. Phase II covers Years 4 to 6, in which the curriculum is extended to include the knowledge component. The curriculum design of KBSR attempts to achieve the all-round development of an individual, including well-balanced child development. Hence teachers should give more attention to the development of well-adjusted children instead of concentrating only on their cognitive development. In order to achieve this development, the philosophy of KBSR primary school education emphasises that pupils should acquire skills and knowledge through direct experience. This experience encompasses the intellectual, spiritual and physical aspects, i.e. pupils' cognitive development, affective development, and physical development and growth and body movements. This experience must be appropriate



and relevant to the aims of education. This can be achieved through the pupils' active involvement in learning activities. This relates to the teaching and learning processes that are appropriate to the particular pupils and the aims to be achieved. Every pupil is unique, with different experiences, behaviour, aptitude and ability. To achieve well-balance development, these individual differences are reflected in the teacher's teaching plan. Based on these considerations, KBSR emphasises the following factors:

- remedial
- enrichment
- continuous classroom evaluation
- integrated
- absorption

(Malaysian Education Ministry 1983)

In KBSR remedial teaching refers to the special teaching and learning processes for pupils with problems and difficulties with skills in reading, writing and calculating. If a pupil is identified as failing to follow a standard programme provided by the teacher, he/she will be given an alternative activity in order to achieve the skill required. However, the pupil will also be given the opportunity to follow the enrichment activities based on his/her abilities and capabilities.

The enrichment activities are the additional activities that consist of elements to widen the pupils' knowledge and experience and to strengthen the skills acquired. Through these enrichment activities, pupils will have the additional opportunity to enhance their interests, creativity, leadership, etc. It is hoped that pupils will be taught to have confidence in themselves, and will be involved in making decisions for themselves, their group and community in the future.

**Continuous classroom evaluation** is the main basic element in the KBSR. It is the aspiration of the program to ensure the overall development of the individuals reaches the maximum level that can possibly be achieved and this depends on their abilities and interest. The evaluation system in KBSR takes account not only pupils' achievement, but also the development of their talents and relationships with other pupils and their peers. The evaluation system planned for KBSR has the following characteristics:

- it is not centralised at the national level
- it is aimed at helping pupils in their learning and remedial activity
- it uses two types of assessment: formal and informal
- it has a multi-format structures
- it is carried out continuously so that pupils' weaknesses do not accumulate
- it is developed, administered and assessed by teachers themselves

(Malaysian Ministry of Education 1983)

The KBSR also places an emphasis on **integration**. As KBSR prioritises basic skills, it encourages teachers to integrate several skills into one lesson. Through the integration process, a number of skills can be achieved simultaneously and the integration strategy will help to strengthen the skills. Skills can be integrated in two ways:

1. Integration of skills can be carried out in one subject. For example in Language, there are four main skills: listening, oral, reading and writing. Two or more skills can be integrated in one teaching and learning session.
2. Integration can also occur between one subject and another or several other subjects. For example, language skills can be integrated with artistic, music, or physical education skills.

(Malaysian Ministry of Education 1983)

Even though in Phase I the achievement in basic skills is of the utmost importance in KBSR, this does not mean that pupils are not exposed to knowledge. Knowledge of Man and Environment is also absorbed in Language and in other subjects so that these lessons also contribute to pupils' understanding. On the other hand, knowledge



of Man and Environment is introduced to the pupils indirectly before it is taught as a subject in Phase II. For example, the oral skill in Language can focus on trees in the environment, and, using a question and answer technique, the teacher can introduce pupils to an understanding of plants, which will be taught later in Man and Environment.

Pupils in the primary school are given the opportunity to express feelings and ideas through speech, art, music, dance and movement and acting. Adequate opportunities must be provided to nurture the creativity of the pupils. For example, teachers can provide pupils with activities such as carrying out a project. As an example, a teacher might initiate a project about “Birds”. Students are encouraged to integrate a lot of material in the project. For example, they may illustrate it with photos or drawings, develop a model, collect information from books, newspapers or magazines, and write about the project topic. In this way, pupils’ creativity in developing the project can be encouraged and enhanced.

The school should also provide pupils with the opportunity to acquire real-life experiences; such as facing problems, exchanging opinions and developing understanding and co-operation. Therefore, the KBSR gives guidance to teachers on how to organise their classroom to provide the right conditions for KBSR teaching.

There are two guidelines:

- on the arrangement of furniture in the classroom for group work
- on utilisation of learning space

To provide the opportunities for the exchange of opinions and for co-operation, teachers are encouraged to do group work and to facilitate discussion amongst the pupils. The desks are clustered and the number of pupils per group is ideally about 6.

This will encourage pupils to interact with each other. When the desks and chairs are arranged in clusters, there is room for the teachers to allocate, in the classroom, some 'learning space'. This space can be allocated as a reading area, where a number of activities can be carried out, such as reading, discussion, acting, etc. Other learning spaces might be allocated to display teaching and learning materials and also the equipment children might use in their learning. The aims of having learning spaces are:

- to provide an attractive working environment (Children are also encouraged to bring a variety of materials to school)
- to enable pupils to move around and interact with the materials
- to enable pupils to carry out small group or individual activities in a more comfortable space
- to give the pupils easy access to learning materials

(Malaysian Ministry of Education 1983)

Such a classroom atmosphere should elicit and encourage pupils to think, ask questions and exchange ideas, thus promoting their overall development (Ministry of Education 1983).

In summary primary education in Malaysia pays close attention to the overall development of the pupils rather than emphasising any particular aspect. This is to be achieved through the approach discussed above. It is hoped that every pupil will experience a balanced development in intellectual, spiritual, emotional, social and aesthetic values, and physical aspects, with an emphasis on reading, writing and calculating skills. This aspiration is similar to that of the National Curriculum in England and Wales, as stated in *The Curriculum from 5 to 16: Curriculum Matters 2* (DES 1985):

*'A school's curriculum consists of all those activities designed or encouraged within its organisational framework to promote the intellectual, personal, social and physical development of its pupils'. (DES 1985, para 11, p.7)*



The curriculum should aim to be broad by bringing all pupils into contact with an agreed range of areas of learning and experience. It should also be balanced in that it allows the adequate development of each area:

*'In addition, each major component should have breadth, balance and relevance and should incorporate a progression in the acquisition of knowledge and understanding. The various curricular areas should reinforce and complement one another so that the knowledge, concepts, skills and attitudes developed in one area may be put to use and provide insight in another, thus increasing the pupils' understanding, competence and confidence'.*

(DES 1989a, para12, p.7)

The curriculum should provide 'reasonable time' for the core subjects and foundation subjects plus religious education and other subjects not covered by the National Curriculum (Campbell and Neil 1994).

Both the Malaysian KBSR curriculum and the National Curriculum in England and Wales are similar in their intention of producing well-developed pupils, but each curriculum has its own approach. The National Curriculum in England and Wales emphasises that the curriculum should be balanced and broadly based. On the other hand the Malaysian KBSR curriculum emphasises all-round and well-balanced child development. However, both curricula aim to promote the intellectual, spiritual and physical development of the pupils. The difference between these curricula is that the Malaysian KBSR emphasises the basic skills knowledge of the 3 Rs in the early phase of the primary school, whereas Key Stage One in the National Curriculum (Ages 5-7) includes the study of English, Mathematics, Science, Technology and Humanities and Arts. Both curricula have similar targets for the pupils, but they are different in their approach and content.

**1.2.2 The new integrated secondary school curriculum**

KBSM, the New Integrated Secondary School Curriculum, was designed in such a way that students would not be forced into a heavily biased Arts or Science stream at the Upper Secondary Level. Students are required to take elective courses from both Humanities and a Science strand (Table 1.2). This is to ensure that the students experience a balance between the two domains. The secondary school curriculum is divided into two levels: the lower secondary level, consisting of Forms 1 to 3 (ages 13-15) and the upper secondary level, consisting of Forms 4 to 5 (ages 16-17 years). The students take a common national examination at the end of the lower secondary level known as Lower Secondary Assessment (Penilaian Menengah Rendah, PMR) and another at the end of Form 5 known as the Malaysian Examination Certificate (Sijil Peperiksaan Malaysia, SPM). As shown in Table 1.1, the lower secondary school subjects are categorised as core and additional subjects. The tables below are a summary of the curriculum designed for the KBSM.

Core Subjects	Additional Subjects
<ul style="list-style-type: none"><li>• Bahasa Malaysia</li><li>• English Language</li><li>• Mathematics</li><li>• ** Islamic Religious Studies</li><li>• ** Moral Education</li><li>• Science</li><li>• History</li><li>• Geography</li><li>• Living Skills</li><li>• Physical and Health Education</li></ul>	<ul style="list-style-type: none"><li>• Chinese Language</li><li>• Tamil Language</li></ul> <p>** When Muslim pupils and others who choose to study Islamic Religious Education are studying the subject, pupils of other religions will be required to study Moral Education.</p>

Table 1.1 The Integrated Secondary Curriculum (KBSM) for lower secondary

At the end of Form 3 all students sit for a common public lower secondary school examination, the Lower Secondary Assessment (PMR). This examination will be based on the three years education of the Lower Secondary Level, for all subjects. The results will determine the elective subjects the students are able to select in



Form 4 (Table 1.2). They will still have to take the core subjects, except for geography and living skills, which are only for the lower secondary school level.

Core Subjects		Additional Subjects			
<ul style="list-style-type: none"><li>• Bahasa Malaysia</li><li>• English Language</li><li>• Mathematics</li><li>• ** Islamic Religious Studies</li><li>• ** Moral Education</li><li>• Science</li><li>• History</li><li>• Physical and Health Education</li></ul>		<ul style="list-style-type: none"><li>• Chinese Language</li><li>• Tamil Language</li></ul> <p>** When Muslim pupils and others who choose to study Islamic Religious Education are studying the subject, pupils of other religions will be required to study Moral Education.</p>			
Electives					
Group I(Humanities)		Group II (Vocational and Technology)		Group III (Science)	
<ul style="list-style-type: none"><li>• Malay Literature</li><li>• Literature in English</li><li>• Islamic Thought</li><li>• Geography</li><li>• Art Education</li><li>• Music</li><li>• Other Languages</li></ul>		<ul style="list-style-type: none"><li>• Principles of accounts</li><li>• Basic Economic</li><li>• Commerce</li><li>• Agricultural Science</li><li>• Home Science</li><li>• Additional Mathematics</li><li>• Workshop Practice</li><li>• Engineering</li><li>• Surveying</li><li>• Building Construction</li><li>• Geometrical and Mechanical Drawing</li><li>• Practical in Electrical Technology</li><li>• Computer Science</li></ul>		<ul style="list-style-type: none"><li>• Additional science</li><li>• Physics</li><li>• Chemistry</li><li>• Biology</li></ul>	

Table 1.2 The Integrated Secondary Curriculum (KBSM) for upper secondary  
(cited in Syarifah Maimunah and Lewin, 1991)

1.3 The Evaluation of the KBSR Programme

A national seminar on the evaluation of the implementation of the KBSR programme was conducted in May 1990. Papers were presented from the academic professional bodies based on studies they had carried out. The subjects of the papers varied from a study of the headteachers’ strengths and weaknesses on the implementation of the KBSR programme to the analysis of the programme from pupils’ and teachers’ perspectives. Most of the papers concluded that KBSR programmes need to be re-evaluated and steps need to be taken to resolve the problems.

In 1993, the Central Curriculum Committee (CCC) held a meeting on the re-evaluation of the implementation of the KBSR programme. There were a number of issues raised which were categorised as 'general' and 'specific'. CCC gathered opinions from the Headteachers Council, the Teachers' Union, Professional Bodies, and Parent-Teachers Associations on the issues raised in the KBSR programme. Among the suggestions made was that the Man and Environment (MAE) curriculum needed to be divided into one of the following;

- History and Geography, and Science and Health
- History and Geography, and Science and Living Skills.
- History, Geography, and Science

This meeting was held in January 1993, and another was held in September of the same year, where CDC presented a working paper on the primary school science curriculum. At this meeting it was decided by the chairman of the CCC that there would not be a trial of the primary science curriculum. It would be implemented without trial in December 1994. Thus, the new innovation was implemented in an ad-hoc and hasty manner.

However, prior to this, in 1992, CDC carried out a study of Year 6 pupils' achievement in science (within the Man and Environment subject). The findings showed that pupils' science achievement was quite low, with a mean score of 51.2%. Only 14.2% were able to achieve cognitive ability, and pupils' weaknesses in higher-process science skills such as analysing and concluding were apparent. This finding played an important role in providing evidence of the failure of Man and Environment to develop pupils with scientific abilities. Other evidence of the failure of MAE was presented in the national seminar in 1990. Professor Ishak Haron wrote of the failure of the subject to be presented as an integration of knowledge of Man



and Environment. Instead, in reality, the subject included non-integrated concepts, skills and knowledge. This, he said, could be seen in the textbook. He further argued that there is an imbalance between the subjects integrated and taught in MAE. Finally, there was a further curriculum innovation and the programme for the primary school curriculum was called Integrated Primary School Curriculum. It was implemented in December 1994. The Man and Environment subject was finally divided into two subjects: science and local studies. The next section will discuss in detail the design, aims, rationales, and principles of the Integrated Primary School Curriculum.

#### 1.4 The Integrated Primary School Curriculum

Table 1.3 shows the structure of the new KBSR.

Communication	Basic skills	PHASE 1	PHASE 11
		Bahasa Malaysia English Language Chinese Language Tamil Language Mathematics	Bahasa Malaysia English Language Chinese Language Tamil Language Mathematics
Man and Environment	Spiritual, Values and Attitudes	Islamic Religious Education Moral Education	Islamic Religious Education Moral Education
	Humanities and the Environment	—	Science * Local Studies*
Individual Self–development	Living Skills	—	Living Skills**
	Arts and Recreation	Music Art Education Physical and Health Education	Music Art Education Physical and Health Education.
	Co-curriculum		

Table 1.3 The structure of the new KBSR curriculum design

\* Man and Environment as a subject is replaced by Science and Local Studies in stages in Years 4 and 5 and completely by year 6 in 1997.

\*\* The Living Skills subject has been implemented in the primary school since 1992/1993 session in year 4 pupils.

(CDC 1994a)

Eleven years after the implementation of the KBSR curriculum, there was another innovation. In December 1994 the **Integrated Primary School Curriculum** (known in Bahasa Malaysia by the acronym **Kurikulum Bersepadu Sekolah Rendah, KBSR**, hereafter designated **new KBSR**) was implemented, replacing the original KBSR.

Three new subjects were introduced: Living Skills, Science and Local Studies.

Health elements were introduced within the Physical and Health Education subject areas. A new field is included in Islamic Religious Education: 'Asas Akhlak Islamiah' (Basic Islamic Morals). The latter emphasises the building of the personality of the pupil in accord with Islamic behaviour and values. The pupils are taught good Muslim characteristics and the moral system of Islam.

Morality means the right and wrong of an action; a set of rules of conduct based on the principles of 'right' conduct rather than on Law or Customs. The words 'right', 'wrong', 'good', 'bad', 'virtuous' and 'evil' are terms denoting value judgement while terms like 'charity', 'humility', 'truthfulness', 'justice' and 'bravery' are descriptive terms, designating a particular mode of behaviour. Whether a particular attitude or action is considered good or bad depends upon the criterion by which human actions are judged. In Islam this criterion is Quran and *Sunnah* (the practice of the prophet Muhammad, Peace be upon Him). It is hoped that, with this knowledge, Muslim pupils will internalise Islamic moral values and Muslim behaviour, and will finally develop the good personality of a Muslim.

In Moral Education the number of values to be taught was increased from 12 to 16. The 16 values are kindness, self-reliance, high principles, respect, love, justice, freedom, courage, physical and mental cleanliness, honesty, industry, co-operation,



moderation, thankfulness, rationality and socialisation. Lesson in Moral Education is usually taught by using stories, songs, poems, newspaper articles, etc. The methods that teachers can apply in moral teaching are role-play, simulation, project, inquiry etc. For example, in teaching the value of rationality, a teacher can incorporate the sub-value of rationality, i.e. consideration in making judgements. To teach this value, for example, a teacher can use a story that relates to it. After listening to the story, pupils are given activities or situations that will give them the opportunity to reason out the value being taught, and at the end of the lesson the pupils should be aware of the importance of giving consideration, i.e. being rational in making judgements. In a Moral Education lesson, emphasis is placed on inculcating the reasoning of morals, moral behaviour and moral emotion. Written exercises are not regarded as very important in moral education. If a teacher gives any written exercise, it will not be in a cognitive form but more of a situational question format that ask the pupils to apply the values taught. All 16 values are taught to pupils from Year 1 to 6. The difference is the in stories and issues raised in the lesson. For the Year 1 pupils the issues are closer to the pupils themselves, and their families and friends; but for the Year 6 pupils the issues are related to their neighbours, communities and nation.

There are a number of emphases within the new KBSR. One of these is ‘values’ across the curriculum. Even though the noble values are taught in Islamic Religion Education and Moral Education they are also emphasised in other subjects and are to be taught directly or indirectly through situations in the classroom. To enhance learning in the classroom, the noble values can be practised in the co-curriculum activities during the interaction with others in or outside the school compound. For

example, in uniformed clubs or societies such as Girl Guides, Boy Scouts etc., teachers can indirectly inculcate the values during their activities. The pupils can thus be taught values such as kindness, self-reliance, respect and caring during a camping session where many interactions occur. In the process, many unplanned occurrences will teach the pupils to develop co-operation, socialisation and many more sub-values which can be instilled indirectly.

Another emphasis is on **patriotism** across the curriculum. The aim of this element is to produce in the generation a love for the country and pride in being a Malaysian. A patriotic element is to be instilled through all subjects and be taught across the curriculum. It can also be instilled through co-curriculum and community service activities. For example, in the science curriculum, this patriotism element is introduced in one component i.e. Investigating the Technological World. In the lesson on appreciating the contribution of inventors to the world, besides teaching the pupils about inventors from the West, teachers also introduce inventors from Malaysia, for example Zulkifli Haron, who has developed robots, a solar powered bicycle, a telephone that is able to communicate with household appliances, etc. In co-curriculum activities, the national anthem will usually be sung at the beginning of the activity out of respect and love for the nation, and this will teach and instil a patriotic spirit among the younger generation.

The aim of the new KBSR is to ensure the development of pupils' potentials in a holistic, balanced and integrated. This development includes intellectual, spiritual, emotional and physical aspects in order to produce balanced, harmonious and good moral pupils. This new KBSR incorporates the same aspects of pupils' development as the **original** KBSR, but the difference is that the original curriculum focused on



the basic skills, the 3 Rs. By contrast, the new KBSR not only attaches importance to the 3 Rs but incorporates many other aspects. Therefore, to achieve the aim of the new KBSR, the current objectives of primary education seek to enable pupils to:

- master the Malay Language in the context that it is the National Language of the country
- master basic language skills, i.e. converse, read and write in the medium of instruction of the schools
- master basic skills of arithmetic and be able to use them to solve everyday problems
- acquire learning skills
- acquire thinking skills
- speak, read, write and understand the English Language in the context that it is a second language
- acquire knowledge and make the effort to increase it
- develop leadership attitudes and self-confidence
- have knowledge, understanding, interest and sensitivity towards man and the environment
- develop scientific and technical skills
- understand, be interested in, appreciate and be involved in charity activities, art and recreation in the national cultural circle.
- care for their own health and fitness
- develop the skills and form an interest with positive attitudes towards entrepreneurial activity and productivity
- develop the reading skills and an understanding of the verses in the Quran (for the Muslim pupils)
- have faith in the Islamic values and practice the noble Islamic values (for the Muslim pupils)
- develop values of patriotism
- develop talents and creativity
- practice attitudes and behaviour in line with the noble values and practice them in their everyday lives

(CDC 1994a)

These objectives can be categorised into five groups (see Table 1.4):

- self-development for lifelong education
- intellectual development
- spiritual development
- emotional development
- physical development

According to the official directives, in implementing KBSR, teachers are reminded to give emphasis to the aspects below in their teaching of any subject:

- basic skills
- thinking skills
- values across the curriculum
- language across the curriculum
- patriotism across the curriculum
- pupil-centred teaching and learning strategy
- continuous evaluation
- remedial and enrichment
- flexibility
- science and technology across the curriculum

(CDC 1994a, p.47)

The above components are to be practised in all disciplines at the primary level, and teachers are to plan their lessons in such a way that these components are integrated into their lessons as much as possible.

CATEGORIES	OBJECTIVES
Self-development for lifelong education	<ul style="list-style-type: none"><li>• acquire learning skills</li><li>• acquire thinking skills</li><li>• develop leadership attitudes and self-confidence</li><li>• develop talents and creativity</li><li>• acquire knowledge and make the effort to increase it</li></ul>
Intellectual development	<ul style="list-style-type: none"><li>• master the Malay Language in the context that it is the national Language of the country</li><li>• master basic language skills, i.e. converse, read and write in the medium of instruction of the schools</li><li>• master the basic skills of arithmetic and be able to use them to solve everyday problems</li><li>• speak, read, write and understand the English Language in the context that it is as a second language</li><li>• develop scientific and technical skills</li><li>• develop skills and form an interest with positive attitudes towards entrepreneurial activity and productivity</li></ul>
Spiritual development	<ul style="list-style-type: none"><li>• develop reading skills and an understanding of the verses in the Quran (for the Muslim pupils)</li><li>• have faith in the Islamic values and practice the noble Islamic values (for the Muslim pupils)</li><li>• practice attitudes and behaviour in line with the noble values and practice them in their every day lives</li></ul>
Emotional development	<ul style="list-style-type: none"><li>• understand, be interested in, appreciate and become involved in charity activities, art and recreation in the national cultural circle</li><li>• develop values of patriotism</li></ul>
Physical development	<ul style="list-style-type: none"><li>• care for their own health and fitness</li></ul>

Table 1.4 The categories of the primary school objectives

The new KBSR curriculum is based on the National Educational Philosophy, which advocates an integrated approach (with different emphases from the old curriculum) to the curriculum. The National Educational Philosophy states that:

*‘Education in Malaysia is an on-going effort towards further developing the potential of individuals in a holistic and integrated manner, so as to produce individuals who are intellectually, spiritually, emotionally and physically balanced and harmonious, based on a firm belief in and devotion to God. Such an effort is designed to produce Malaysian Citizens who are knowledgeable and competent, who possess high moral standards, and who are responsible as well being able to contribute to the harmony and betterment of the family, the society and the nation at large’. (Ministry of Education 1997)*



In this integrated approach, the elements of knowledge, skills and values are integrated so that the intellectual, spiritual, emotional and physical aspects are developed in the pupils. Therefore the new KBSR attempts to ensure that all subjects play a role in fulfilling pupils' various needs. Integration can be achieved in various ways, for example:

- Integration of skills between subjects – e.g. a cross-curricular subject approach;
- Integration of values in subjects – e.g. the cleanliness and safety aspects emphasised during practical activity;
- Cross-curricula elements including: language across the curriculum, environment across the curriculum, science and technology across the curriculum, patriotism across the curriculum, thinking skills across the curriculum, and learning skills across the curriculum;
- Integration between curriculum and extra-curricular activities. Extra-curricular activities strengthen the curriculum activities in classroom – e.g. a science club;
- Integration between knowledge and practice – e.g. knowledge gained in the classroom becomes the basis of practice in daily life;
- Integration between children's existing knowledge and new experiences. (CDC 1994a)

In summary, integration can be implemented through the curriculum, i.e. through knowledge and skills, values, language, extra-curricular activities and also school culture. The school culture includes the physical and non-physical environment of pupils in the schools. An environment that is encouraging and supportive would give a positive impact on the teaching and learning processes, and inculcates the noble values. The physical environment of the school can contribute by having a reading corner or reading garden in addition to the library so as to enhance pupils' interest in reading, locating information, or following up references. Schools should encourage the aspects of good human interactions and relationships. Schools have to promote a sense of belonging. A school can be compared to a happy family and pupils should feel that the school is a place where they can be content, thereby promoting a positive attitude towards knowledge and the school itself.

Another emphasis of the new KBSR concerns the holistic development of individuals. The curriculum ensures that all subjects will play a role in fulfilling the

intellectual, spiritual, emotional and physical aspects. Holistic development means that individual potentials cannot be developed separately. Every potential developed has to be interrelated with others. For example, in sports or games, the above aspects cannot be separated from the social aspects. Knowledge in games is the intellectual aspect, where pupils need to know how to play sports or games according to rules and regulations. Team spirit, good sportsmanship and the spirit to play for the nation constitute the spiritual aspect that pupils need to develop. These two potentials have to be interrelated so that pupils become holistic individuals inspired by the curriculum.

The new KBSR program also aims to provide equal education for all pupils to enable them to acquire knowledge, skills and balance through direct experiences. This is done, for instance, by having the same curriculum content for all pupils. Another aspect of the new KBSR programme is to provide for lifelong education. Learning is a continuous effort and the school level is only the beginning. Hence, education in school should prepare pupils for continuity of learning in their future lives.

According to this principle, the knowledge and skills provided in the KBSR programme are the basics needed by the pupils to understand their everyday experiences, and they become the foundation for lifelong education. Therefore, educational processes should not stop at the end of schooling but should be a continuous element of lifelong learning. Education is not just the acquisition of knowledge but the development of the individual in attaining increasing self-realisation as the result of successive experiences. As Lengrand (1975) states:

*'The prospect of instituting lifelong education, and the need for it, are to be judged not in relation to other people or to a given body of knowledge external to the pupil, but in relation to the personal development of a particular individual'. (p.51)*



Cropley (1980) argues that:

*'Lifelong education conceptualised as a means for facilitating life long learning would:*

*2) lead to the systematic acquisition, renewal, upgrading and completion of knowledge, skills and attitudes, as became necessary in response to the constantly changing conditions of modern life, with the ultimate goal of promoting the self-fulfilment of each individual'. (p.3)*

Thus the KBSR curriculum aims to provide pupils with life-long learning by providing appropriate opportunities for everyone throughout their lives. This means that educational provision should provide opportunities to any individual for furthering their educational development. As Cropley (1980) suggested, the systematic acquisition of knowledge, skills and attitudes is essential as a preparation for lifelong learning. Cropley (1980) further argues that:

*'The kind of characteristics needed for purposeful lifelong learning include the skills necessary for learning under different circumstances and at different times, the motivation to carry out such learning, the image of oneself as a learner, a positive attitude to learning, the ability to set goals and evaluate the extent to which they have been achieved, a realistic appraisal of own potentials, a constructively critical attitude to oneself, society and knowledge, and similar characteristic'. (p.6)*

This reflects the specific aims of the new KBSR: developing learning skills and thinking skills, and making an effort to increase acquired knowledge. Thus, the purpose of education is not to teach a fixed quantity of facts but to teach the art of learning and learning continually (Maheu 1973). It is no longer merely a matter of transmitting a static body of values and skills, rather the aim is to help the child realise from the outset that some of the intellectual, scientific and ethical content of the education received is bound to change (Adiseshiah 1970). Therefore the new KBSR emphasis on lifelong education is important in preparing our children for their future lives. As Dave (1976) stated:

*'A major concept in lifelong education is that knowledge is a continuous fabric. Hence its content should stress the unity of knowledge, in a number of ways. Within particular disciplines, broad disciplines and general implications should be emphasised. Across disciplines, there should be a horizontal integration of arts and science, so those boundaries between disciplines will tend to disappear'. (p.368)*

These statements support the new KBSR integrated approach in trying to develop holistic individuals. It implies that by promoting the integrated approach in the curriculum, KBSR also caters for lifelong education.

In summary, the new KBSR principles emphasise the integrated approach, holistic individual development, equal education for all pupils, and lifelong learning.

Teachers must therefore relate their teaching and learning objectives to students' abilities, using a variety of techniques, including teaching and learning aids that are interesting and match the needs and abilities of all the pupils. As Holt (1994) observes:

*'A child is most intelligent when the reality before him arouses in him a high degree of attention, interest, concentration, involvement - in short, when he cares most about what he is doing. That is why we should make schoolrooms and schoolwork as interesting and exciting as possible, not just so that school will be a pleasant place, but so that children in school will act intelligently and get into the habit of acting intelligently'. (p.10)*

This implies that primary school teachers must have a strong knowledge base within classroom teaching and learning processes in order to provide interesting and exciting schoolrooms and schoolwork for their pupils. With good pedagogical content knowledge (Shulman 1987), teachers should be able to improve primary school education, and most of the aims of the new KBSR will be achieved. This means that by possessing a good content knowledge of the subject, teachers should be able to transfer the knowledge to the pupils. To do this teachers need a secure knowledge of pedagogy. They also need knowledge of their pupils' characteristics in order to plan suitable activities in accord with their pupils' abilities. The combination of content knowledge and pedagogical knowledge will enable teachers to solve problems of learning and teaching. As explained by Shulman (1986):

*'Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently*



*taught topics and lessons. If those preconceptions are misconceptions, which they so often are, teachers need knowledge of the strategies most likely to be fruitful in reorganising the understanding of learners, because those learners are unlikely to appear before them as blank slates'. (p.10)*

Thus, it is important for teachers in Malaysia, when teaching the new KBSR program, to have the necessary pedagogical content knowledge to be able to produce the holistic and balanced individuals, as intended by the new curriculum. The importance given to children's development in the new KBSR programme supports Shulman's argument that children should not be considered as blank slates, but the aim must be to build on their initial ideas. In this way, teachers will be able to direct their teaching to the needs and abilities of individual pupils. Hence teachers must plan their teaching strategies in order to achieve the children's holistic development - intellectually, spiritually, emotionally and physically — in the Malaysian context.

### **1.5 A Comparison of the Objectives of the Malaysian and the National Curriculum in England and Wales**

Comparing Malaysian objectives for primary education with the requirements of its National Curriculum shows that there are similarities. The National Curriculum also emphasises a balanced and broadly based curriculum which should promote the spiritual, moral, cultural, mental and physical development of the pupil (Emmerson and Goddard 1989). The DES (1985) defines the meaning of broad and balanced as follows:

*'The curriculum should aim to be broad by bringing all pupils into contact with an agreed range of areas of learning and experience. It should be balanced in that it allows the adequate development of each area. In addition, each major component should have breadth, balance and relevance and should incorporate a progression in the acquisition of knowledge and understanding. The various curricular areas should reinforce and complement one another so that the knowledge, concepts, skills and attitudes developed in one area may be put to use and provide insight in another, thus increasing the pupils' understanding, competence and confidence'. (para 12, p.7)*

This is similar to the emphasis in the new KBSR on the potential development of children as holistic, balanced and integrated. This development includes the intellectual, spiritual, emotional and physical aspects to produce a balanced, harmonious and good moral human being. This is done through an integrated approach to the curriculum.

The National Curriculum in England and Wales also emphasises that the curriculum should prepare the pupils for the opportunities, responsibilities and experiences of adult life:

*'The curriculum should be relevant in the sense that it is seen by pupils to meet their present and prospective needs. Overall, what is taught and learned should be worth learning in that it improves pupils' grasp of the subject matter and enhances their enjoyment of it and their mastery of the skills required; increases their understanding of themselves and the world in which they are growing up; raises their confidence and competence in controlling events and coping with widening expectations and demands; and progressively equips them with the knowledge and skills needed in adult working life. Such a curriculum will be practical in that it serves useful purposes and is seen to do so by pupils, parents and their wider society. Thus relevance and practicality are closely related but not always synonymous.'* (DES 1989a, para 116, p.45)

This points to a similarity with Malaysia's new KBSR, which states that the objectives of primary education are to provide the opportunity for children to acquire knowledge, and to develop the initiative and determined to increase their knowledge independently. This will lead to the development of leadership qualities in children and boost their self-confidence (CDC, 1994a). These children will display the knowledge, understanding and interest towards human beings and the environment, thereby developing a sense of responsibility in the children which will become a basic value of their adult life. One of the objectives stated in the new KBSR is that the children will be provided with the opportunity to acquire skills and develop an interest in, and positive attitudes towards, entrepreneurship and productivity in the Malaysian context. This can be seen as another similarity with the National



Curriculum in England and Wales, which seeks to prepare children for adult life and the world of work (DES 1985).

The objectives of the school curriculum in the National Curriculum also state that it should be differentiated (DES 1985) so that what is taught and how it is taught match and develop individual abilities and aptitudes. This resembles the teaching and learning strategy suggested in the new KBSR program, which states that teachers should take into consideration the multiple abilities of the pupils. Therefore teachers are encouraged to use various methods and techniques when considering the development, ability, interest, talent and learning styles of children. Hence, this will determine what teachers teach and how teaching is matched to individual abilities and aptitudes. However, Office for Standards in Education (OFSTED) (1994) also found that:

*'Good achievement by pupils was also associated with teachers who had high but realistic expectations and who planned thoroughly to achieve an effective match between the task set and the pupils' developing abilities. In a majority of the lessons, however, especially in Key Stage 2 the work closely matched only the abilities of the average pupils, and left the more able insufficiently challenged, and the less able unable to cope with key aspects of the lesson content. Teachers' expectations of pupils seemed to be shaped by two powerful factors: their understanding of the subject content they were required to teach and their perceptions of the ability of the children to profit from that teaching. It was often the first of these factors which presented the greatest obstacle to progress because the lack of subject knowledge stood in the way of planning sequences of work to a sufficient depth and presenting subject content in different ways in response to pupils' levels of understanding'. (para 13, p.3)*

This shows that the National Curriculum in England and Wales, in trying to promote a differentiated curriculum, has faced some obstacles. In particular, even though the proposal is for a differentiated curriculum, this aim is not always realised due to some teachers' inability to deliver what is required.

The above comparisons reveal that the curriculum objectives of Malaysia's new KBSR and of the National Curriculum in England and Wales have much in common.

Both have been developed to produce a better quality of education for the children of the nation. This in turn means that excellent teachers will be needed to improve the quality of education. Thus, the teacher education program will have a vital role to play. Table 1.5 presents a comparison of the Malaysian KBSR and the National Curriculum in England and Wales.

COMPONENTS	MALAYSIAN KBSR	NATIONAL CURRICULUM IN ENGLAND AND WALES
Pupil Development	Intellectual, spiritual, emotional and physical — Holistic, balanced, harmonious and good moral	Spiritual, moral, cultural, mental and physical
Curriculum	Integrated, holistic, equal education for all and lifelong learning	Breadth, balance, relevance, differentiation, progression and continuity
	<ul style="list-style-type: none"> <li>• Master the Malay Language in the context that it is the National Language of the country</li> <li>• Master the basic language skills i.e. to converse, read and write in the medium of instruction of the schools</li> <li>• Master the basic skills of arithmetic and be able to use them to solve everyday problems</li> <li>• Acquire learning skills</li> <li>• Acquire thinking skills</li> <li>• Speak, read, write and understand the English Language in the context that it is a second language</li> <li>• Acquire knowledge and make the effort to increase it</li> <li>• Develop leadership attitudes and self- confidence</li> <li>• Have knowledge, understanding, interest and sensitivity towards man and the environment</li> <li>• Develop scientific and technical skills</li> <li>• Understand, be interested in, appreciate and be involved in charity activities, art and recreation in the national cultural circle</li> <li>• Care for their own health and fitness</li> <li>• Develop skills and form an interest with positive attitudes towards entrepreneurial activity and productivity</li> <li>• Develop reading skills and an understanding of the verses in the Quran (for Muslim pupils)</li> <li>• Have faith in Islamic values and practice the noble Islamic values (for Muslim pupils)</li> <li>• Develop the values of patriotism</li> <li>• Develop talents and creativity</li> <li>• Practice attitudes and behaviour in line with the noble values and practice them in their everyday lives</li> </ul>	<ul style="list-style-type: none"> <li>• to help pupils develop lively, inquiring minds, the ability to question and to argue rational and apply themselves to tasks, and physical skills</li> <li>• to help pupils acquire knowledge and skills relevant to adult life and employment in a fast-changing world</li> <li>• to helps pupils to use language and numbers effectively</li> <li>• to instil respect for religious and moral values, and tolerance of other races, religions and ways of life</li> <li>• to help pupils understand the world in which they live, and the interdependence of individuals, groups and nations</li> <li>• to help pupils appreciate human achievements and aspirations</li> </ul>

Table 1.5 A comparison of the new KBSR and the National Curriculum in England and Wales

### 1.6 The Implementation of Curriculum Innovation

Education has always been a dynamic field. This is especially so in respect of changes that occur in the school curriculum. A fundamental reason for producing a new curriculum is to provide better learning opportunities for students; for example,



higher achievement levels in terms of understanding, skills and values. When a new curriculum is introduced, besides the revised goals for the students there will also be changes in the structures, programmes and practices for the teachers and for the schools' organisation.

Before a new curriculum can be implemented, there is a long process of educational change. Most curriculum writers (e.g. Nichols and Nichols 1975, Fullan 1991, Marsh 1992) agree that there are four basic phases in the process of educational change:

- the Orientation/Need phase,
- the Initiation/Adoption phase,
- the Implementation/Initial Use phase,
- the Institutionalisation/Confirmation phase.

In this study, the main area of interest is the implementation phase. Fullan and Pomfret (1977) suggest four reasons for studying implementation. First, if we do not conceptualise and measure implementation, we will not know if there have been any changes. Secondly, we need to understand some of the reasons why many educational changes fail. Thirdly, we need to ensure that the implementation phase is not ignored or confused with other aspects of the process of change, such as adoption. Finally, we need to interpret learning outcomes and to relate these to possible determinants. Thus, educationalists and others involved within the education domain must examine any implementation so that we can find out if any change has occurred and understand its success or failure. However, curriculum change and innovation face many challenges before they can be accepted and *the focus of this thesis will be on the implementation of curriculum innovation at classroom level.*

In any evaluation of curriculum innovation, a major factor will be the teachers themselves, usually referred to as the agents of change during the implementation

phase. According to Fullan and Pomfret (1977), implementation refers to the actual use of an innovation or what it consists of in practice. This means we must examine how the change agents use innovation and put it into practice. Change agents are the most important group involved in curriculum innovation because they are the ones who provide the communication link between the developer and the clients (Marsh 1992). Since change agents in an educational context are the teachers who will implement the innovation, it is necessary to focus on them and how they implement or cope with innovation.

Fullan (1991) includes 'local characteristics' as one of the factors affecting implementation (one of the local characteristics being the teacher). He states that some teachers, depending on their personality, the influence of their previous experiences, and their stage of career development, are more self-actualised and have a greater efficacy, which leads them to take action and persist in their efforts to bring about successful implementation. This implies that not all teachers or agents of change are willing implementers. This makes a study of the teachers themselves as implementers even more important. According to McNeil (1990), there is little financial incentive for teachers in accepting innovation. Indeed teachers may have to work longer in order to implement such changes and may attract criticism from those who are opposed to it. It is more comfortable and a lot safer to be conventional most of the time. This indicates the importance of teachers' acceptance of innovation, because their resentment might result in the failure of innovation.

### **1.7 Curriculum Innovation and Teachers' Thinking**

In order for curriculum innovation to be successful, teachers must act as effective agents of change. Hence, it is important to find out how teachers implement the new



curriculum in their classrooms and whether the implemented curriculum matches the intended curriculum.

Elbaz (1983), in her studies of teachers' practical knowledge, divides the content of practical knowledge into five categories: knowledge of the subject matter, the curriculum, instruction, self and the milieu of schooling. The most important aspect of practical knowledge, for Elbaz, is how teachers hold and use it since this will determine whether the teachers become autonomous agents in implementing curriculum innovation.

Clark and Peterson (1986) categorise teachers thought processes into three domains: teachers' planning, teachers' interactive thought, and teachers' theories and beliefs. In terms of the third domain, they conclude that teachers hold implicit theories about their work, and that these theories can be made explicit in a variety of ways. For example, Olson's (cited in Clark and Peterson, 1986) research on teachers' implicit theories of curriculum innovation found that the most important construct in these theories was classroom influence, whereas Munby (cited in Clark and Peterson, 1986) found that the five most frequently constructed categories mentioned by teachers were: *student learning and developmental goals, student involvement, teacher control and authority, student needs and limitations, and motivation*. Both these studies showed that teachers' implicit theories and beliefs are close to their practical knowledge of the learners' characteristics and are an important component of their curriculum implementation

Clark and Yinger (1979) reported that teachers' thinking involves the processing of cognitive information concerned with teachers' judgement, decision-making and planning, and implicit theories or perspectives. For Clark and Yinger, the thinking

processes that through which teachers collect, organise, interpret and evaluate information will guide and determine teacher's behaviour. In terms of teachers' implicit theories, they conclude that teachers thinking and behaviour are guided by a set of organised beliefs, and that teachers are not conscious of this. Clark and Yinger (ibid.) observe that teachers usually refer to their personal perspective, to implicit theories, to a conceptual system or to a belief system about teaching and learning when they are faced with problems. For teachers, these elements of classroom situations are important in their work. Therefore, teachers' beliefs will influence their work, and if an innovation is to be successfully implemented, it will have to be synchronised with those beliefs.

These studies show that teachers' practical knowledge, implicit theories and pedagogical content knowledge are used to guide their practice and shape their working situations. Therefore, when a curriculum innovation is introduced, teachers will use their practical knowledge to respond to the new curriculum. It will also determine whether an innovation is accepted or rejected.

### **1.8 Teacher Training in Malaysia**

Teacher training colleges and universities provide initial teacher education. At present there are 31 teacher training colleges scattered all over Malaysia. They provide three main types of pre-service programme: a three-year Malaysian Diploma in Teaching (primary school), a one-year Post-Diploma in Teaching (lower secondary or primary school) and a one-year Post-Graduate Diploma in Teaching (secondary school). The teacher training colleges also provide two main types of in-service programme. The Special Diploma in teaching is a one-year programme aimed at upgrading teachers in their respective specialist subject areas. The local



universities accredit the programmes, and participants who excel may continue directly into the second year of their degree programmes. Another programme is the Professional Development Courses, which are 14-week customised courses designed to upgrade and update the professional skills and knowledge of both primary and secondary school teachers. The Teacher Education Division also conducts twinning programmes with local universities and foreign universities to increase the number of graduate teachers. Trained teachers from primary and secondary schools follow these programmes to obtain either a first degree or post-graduate degree.

Teacher education in the university programme leading to a Bachelor's Degree in Education or Post-Graduate Diploma in education is offered in local universities.

The Faculties of Education conduct these programmes. A new Teachers' University known as The Sultan Idris Teachers' University was established in 1997. This university was established in order to increase the number of trained graduate teachers in line with the Ministry of Education's policy of eventually having graduate teachers in all primary and secondary schools.

When the change to the Malaysian primary curriculum was implemented in December 1994, the Teacher Training Division also implemented a new programme for the teaching of the additional subjects. At that time the programme of the teacher trainee was a Malaysian Certificate in Teaching of two and half- years duration for the pre-service course.

By comparison, in the United Kingdom the two most common routes into the teaching profession are the undergraduates Bachelor of Education (B.Ed.) course and the Post- Graduate Certificate of Education (PGCE). The B.Ed. holder will be directed mainly to primary school teaching, whereas the PGCE holder will teach in

either secondary or primary schools. In addition there are smaller School-Based Initial Teacher Training (SCITT) courses in which students' training is based in a school, or consortium of schools, without there necessarily being an input from higher education (Education and Employment Committee 1997)

As in Malaysia, the United Kingdom government also introduced a Graduate Teacher Programme (GTP). This replaced the Licensed Teacher Scheme and Articled Teacher Scheme and offered a route for non-graduates who have successfully completed two years of higher education in the UK or elsewhere. The GTP is an employment-based route into teaching for those who do not wish to go through the traditional pre-service training routes. Those in this scheme will undertake paid work as teachers in school during the training period (House of Commons- Education and Employment Committee 1997).

### **1.9 The Situation during the Initial Implementation of the New KBSR**

This study will focus on the implementation of primary science during a time of curriculum change. At the same time as the primary science curriculum was being implemented in school, the training of teachers for the science option was only just starting. This cohort of trainees will only be posted to schools two and a half years into the implementation of the new curriculum. The training programme is conducted over five semesters and includes knowledge and pedagogical components. The pedagogical component includes the science curriculum, strategies for teaching and learning science, micro and macro teaching, science process skills, the management of science rooms (laboratories), teaching and learning resources, and the evaluation and management of the science curriculum. The content knowledge is



in line with the content of the primary curriculum, but the trainees are taught the content of science up to form five secondary level.

In the United Kingdom, the Department for Education and Employment (DfEE 1998) states, in the 'Requirements for Courses of Initial Teacher Training (ITT)' for primary science, that the curriculum should include the pedagogical knowledge and understanding required by trainees to secure pupils' progress in science and to develop effective teaching and assessment methods and trainees' knowledge and understanding of science. The minimum qualification in science for those who enter the primary and KS 2/3 courses in ITT is GCSE Grade C (or its equivalent) in science, but this does not necessarily mean that the trainees have sufficient science content knowledge for them to feel competent with the science they have to teach. It is stated in the document that the providers of ITT should audit trainees' knowledge, understanding and skills against the science content in the KS1 and KS2 Programmes of Study. If providers identify gaps in trainees' subject knowledge, they must make arrangements to ensure that trainees gain that knowledge and understanding during the course, and that by the end of the course trainees must be confident and competent in using the science specified (DfEE 1998).

In Malaysia, there used to be in-service programmes in 1995 for primary science education, offered by the teachers' colleges for trained teachers and conducted simultaneously with the implementation of the new KBSR. The in-service programmes were either a one-year programme or a 14-week programme focussing on the teaching and learning of primary science. These courses were only offered for two consecutive years and were then stopped because the colleges were directed by the Teacher Education Division to concentrate on the twinning programme. The one-

year course was only conducted in two colleges, with about 25-30 participants in each. Thus the majority of trained teachers teaching science in schools during the period of initial implementation had no formal training in the teaching of science. However, these teachers were given a five-day orientation course supervised by the District Education Office. During this course the key personnel (selected teachers with good teaching records) conducted the in-service course. Teachers were introduced to the new curriculum by lectures with handouts providing much of the information.

In contrast, United Kingdom in-service training for the National Curriculum takes one of two forms: whole school review and raising of awareness. The whole school review uses the Guidelines for Review and Internal Development in Schools (GRIDS) system. There was evidence that this system was favoured by teachers since it focussed their attention on a common list of aspects of school life that might need to be reviewed and from which training needs could be identified. The awareness-raising took the form of day conferences for teachers from the same phase (most frequently primary) or in cross-phase groups consisting of a secondary school with its feeder primary schools. The conference was aimed to provide the necessary information about the National Curriculum. This was a useful way of helping teachers to make sense of the mass of documentation and the unfamiliar language of the National Curriculum, that many regarded as impenetrable. However, there were real dangers of information overload, with too much attempted within a day or even a single session (DES, 1991b). The training to implement National Curriculum science in primary schools was seen as the greatest challenge and given the highest priority by LEAs and schools (DES, 1991b). The courses were planned to meet



teachers' needs in relation to the specified National Curriculum attainment targets.

They also included a day or two variously described as 'Cascade Preparation' or 'The Role of the Curriculum Leader'. However, a report by the DfE (1992) stated

that:

*'There was little evidence of major changes in classroom organisation made to accommodate the National Curriculum. In the more effective schools (about two-fifths of those visited) the approach to grouping pupils was flexible: pupils worked as individuals, in pairs, in small groups or as whole class as the task demanded. The flexibility of this sort made it easier for teachers to match the work to the ability of individuals and to give them a measure of independence and appropriate opportunities for practical work. The danger, particularly for the inexperienced teachers, with so eclectic an approach was that too many things might be happening at once and that some children who needed help or encouragement not be given it.'* (para 61, p.28)

This implies that the training or the INSET for the implementation of the National Curriculum was not very effective. This is supported by the OFSTED (1994) report, which stated that:

*'The most common organisational weakness stemmed from the teachers' failure to vary their favoured grouping strategies, which resulted in too much, or too little, time spent on whole class teaching or on individual work or on group work. In about half of the lessons where pupil's achievements were unsatisfactory, poor pedagogic skills were combined with weak subject knowledge on the teachers part'.* (para 12, p.3)

Following the implementation of the National Curriculum for science in primary schools, Andrew (1996) argued that:

*'Primary teachers express a concern that they do not have sufficient scientific knowledge to be confident to teach science. There are a lot of materials to assist teachers in developing the curriculum. But merely staying one chapter a head of the children does not work. Teachers need to grasp the major ideas that underpin our undertaking of particular scientific phenomena and events. They also need to know how these phenomena and events to relate to each other at a level beyond the one they are teaching so that they are able to guide the child's learning. There is a need for INSET to assist primary teachers to develop their understanding in science at least to GCSE level.* (p.129)

This is supported by OFSTED (1995) in the report "A review of inspection findings 1993/1994", where it recommended steps to be taken to enhance the science subject knowledge of teachers, especially those teaching older Key Stage 2 classes. This is reflected in one of its findings

*'In the great majority of schools, science is taught by the class teacher in Key Stage 1 and 2. Many primary teachers lack the depth of subject knowledge required to underpin rigorous science teaching, especially with older pupils. In a small number of schools, there is some specialist teaching or semi-specialist teaching of science, particularly in Years 5 and 6. This can be an effective strategy for ensuring that pupils are taught by someone with a sound understanding of the subject'.*(para 43, p.16)

The evidence from the implementation of the National Curriculum indicates that teachers still need further support if implementing is to be effective.

Even though the curriculum has now been implemented for five years, there are still a large number of teachers teaching primary science with no formal training in primary science education. Some headteachers in the primary schools hold the view that teachers in such schools are general educationalists, and that they will be able to teach all subjects allocated to them, despite their lack of knowledge in some of them. These teachers receive information on the primary science curriculum informally from colleagues, who have attended the course or have been through a short in-house professional development lasting two to three hours. This raises questions about teachers' understanding, ability, knowledge and credibility when implementing curriculum change, particularly in science at primary school level, and about the effectiveness of the implemented curriculum.

A status report was undertaken by the Inspectorate of Schools, Malaysian Ministry of Education (1995a), on primary science in year 4 in 1995. It found that, from its inspection of 210 schools all over the country, 41% of teachers did not have enough content knowledge to teach accurately science concepts to primary pupils. Most of the teaching strategies used were based on questioning, discussion and lecturing. The questions teachers used did not test and challenge pupils' thinking skills, scientific skills, attitudes and scientific values. The report also stated that the teachers' science process skills, manipulative skills and thinking skills needed serious consideration,



and that that a monitoring system should be employed to evaluate the teaching and learning processes in primary science.

This report was based on an inspection of year 4 pupils in 1995, when the curriculum was initially implemented, and it revealed many problems. Similarly, the School Inspectorate of Penang (Malaysian Ministry of Education, 1995b) in its inspection of primary science in 1995 in primary schools in Penang, found that teachers still saw teaching as a method of imparting concepts and facts to pupils with no activity base to enable pupils to be involved in developing science process skills. The School Inspectorate, in its inspection in Sabah (Malaysian Ministry of Education, 1995c), also found that teachers' strategies were limited to lecturing, questioning and discussion. These reports imply that primary school teachers who teach science do need support in order to implement the primary science curriculum, especially in the teaching and learning of processes. The limited strategies used to teach science indicate that teachers might not understand, or be familiar with, the curriculum guides from the orientation course or the curriculum documents developed by the CDC.

Comparing the Malaysian situation with the implementation of the National Curriculum in England and Wales for science in primary schools, HMI, in its report on teaching and learning science in KS 1 and KS 2 in 1990-1991, reported that 32% of lessons were good or very good and further 34% were satisfactory in KS 1. In KS 2, 24% of the lessons were good or very good, and a further 30% satisfactory. The report stated that in the good lessons, the work was well planned and carefully organised. The teachers' knowledge of pupils' achievement was used to match work to the needs of individual children and teachers' questioning was well considered,

carefully timed and encouraged pupils to question for themselves. The teachers' interventions enabled the children to avoid undue difficulties, but left them room to think things out for themselves; and children were given opportunity to initiate and plan investigations, demonstrate their findings to the rest of the class, and choose and use suitable equipment. In contrast, the poor lessons in both Key Stages showed that the work was inadequately planned and insufficiently related to pupils' previous experience and scientific knowledge, with children often failing to understand either what was expected of them or the content of the lesson (DES 1992).

This evidence clearly shows that the implementation of the primary science curriculum in both countries has not been totally successful and that some of the primary teachers in the UK have managed to implement the curriculum more successfully than their Malaysian counterparts (as reported by the Malaysian Education Inspectorate). Thus, it is important to explore the implementation of this innovation five years later in order to discover the nature and scope of teachers' problems and how teachers are coping with the teaching of primary science.



## **Chapter 2 BACKGROUND TO THE RESEARCH: PRIMARY SCIENCE IN MALAYSIA, INCLUDING SOME COMPARISONS WITH THE UNITED KINGDOM**

### **2.1 Introduction**

This research seeks to explore the implementation of curriculum innovation in the new KBSR with a focus on primary science. Science was chosen for this study because it is a core subject that is central to Malaysian ambition to become a developed country with a scientific and progressive outlook. The Prime Minister, Dr. Mahathir Mohamad in his 1991 speech on 'Malaysia: The Way Forward' (cited in Sarji, 1993) has outlined nine challenges. These are:

- *The first of these is the challenge of establishing a united Malaysian nation with a sense of common and shared destiny. This must be a nation at peace with itself, territorially and ethnically integrated, living in harmony and full and fair partnership, made up of one "Bangsa Malaysia" with politically loyalty and dedication to the nation*
- *The second is the challenge of creating a psychologically liberated, secure and developed Malaysian society with faith and confidence in itself, justifiably proud of what it is, of what it has accomplished, robust enough to face all manner of adversity. This Malaysian Society must be distinguished by the pursuit of excellence, fully aware of all its potentials, psychologically subservient to none, and respected by the peoples of other nations*
- *The third challenge we have always faced is that of fostering and developing a mature democratic society, practising a form of mature, consensual, community-oriented Malaysian democracy that can be a model for many developing countries.*
- *The fourth challenge is the challenge of establishing a fully moral and ethical society, whose citizens are strong in religious and spiritual values and imbued with the highest ethical standards*
- *The fifth challenge that we have always faced is the challenge of establishing a matured, liberal and tolerant society in which Malaysians of all colours and creeds are free to practice and profess their customs, cultures and religious beliefs and yet feeling that they belong to one nation*
- *The sixth is the challenge of establishing a scientific and progressive society, a society that is innovative and forward looking, one that is not only a consumer of technology but also a contributor to the scientific and technological civilisation of the future*
- *The seventh challenge is the challenge of establishing a fully caring society and a caring culture, a social system in which the welfare of the people will revolve not around the state or the individual but around a strong and resilient family system*
- *The eighth challenge is the challenge of ensuring an economically just society in which there is a fair and equitable distribution of the wealth of the nation, in which there is a full partnership in economic progress. Such a society cannot be in place so long as there is the identification of economic backwardness with race*

- *The ninth challenge is the challenge of establishing a prosperous society, with an economy that is fully competitive, dynamic, robust and resilient. (p.403)*

Challenge number six is aimed especially at educators, and has major implication to the teaching of science. With the implementation of primary science in schools, the vision of the Prime Minister might be fulfilled if it is understood and shared by educators at all levels. Aziz (1993) argues that challenge number six concerns the attitudes of both individual minds and society's collective mind:

*'To achieve a scientific society with sufficient attention to numeracy and literacy as well as Information Technology operacy, the education system has to foster scientific attitudes such as to question what is, to seek something better and to consistently proceed according to the scientific method. Innovations, discoveries and inventions come when these attitudes become an integral part of the minds of scientist, managers, administrators and politicians'. (p.333)*

This implies that the educational system in Malaysia must be reformed if challenge number six is to be met. Thus, the first step is innovation of the primary curriculum, where science is introduced. The education system has to foster scientific attitudes from an early stage in children's schooling so that these attitudes will be instilled in them and carried through to their future careers. The implementation of the primary science curriculum is designed to ensure that scientific attitudes will be inculcated in children. As Shohtoku (1993) observes:

*'The education of boys and girls in mathematics and science at an early stage has a strong impact upon their aptitude for and interest in their choice of engineering and technology-related subjects at higher stages of education. A declining level of education, especially in mathematics in certain countries, is causing a great deal of constraint in their effort to enhance international competitiveness and, in some cases, deterioration of industrial strength and research and development. Although emphasis in mathematics and science take many years of continued efforts in school before fruition, it is certainly a task to be implemented in the context of Vision 2020'. (p.303)*

Thus, the implementation of primary science in Malaysian primary schools is an appropriate and important step taken by the country in preparing itself to become a developed nation. However, Omar (1993) argues that:

*'Although curricular reform is a slow process, educational institution must have the capacity to harmonise their activities with the changing global science and technology scene and the local industrial structure as well as with government priorities. This will require reform in*



This implies that educational institutions must play a full role in scientific and technological manpower development in support of national and industrial objectives, identify critical skill areas, mount a concerted effort in upgrading competence in these areas, and create a national culture of continuous education, training and skill development (Omar, 1993). However, to gain the manpower required for scientific and technological work, the country must start at the primary level in order to encourage an interest and ability in these areas.

A study carried out in Malaysia by Molly *et al.* (1996) revealed a falling number of students in the science streams at secondary school. In 1993 the ratio of science students to non-science students was as low as 20:80. This study also analysed the school science curriculum at secondary level and found that pure science subjects were too difficult for students with average ability. This finding supported Yoon Suan's (1995) study of the falling rolls in science. He stated that the most important reason for students choosing or not choosing science was their perceived ability in the subject based on their past performance, their personal liking or interest for the discipline, and parental influence. Science and mathematics were widely perceived to be difficult and demanding. Thus students assumed science was a difficult subject to learn. These patterns added a further urgency to the implementation of science in primary schools in 1994.

In UK, the Assessment of Performance Unit (DES, 1983) revealed a weak performance in science among primary school children. The overall report concluded that children performed less well at science specific-skills compared to general skills. The introduction of the National Curriculum following the 1988

Education Reform Act significantly changed science education in the primary school system (Fortune, Peters and Rawlinson-Winder 1993). This shows that, in UK, the problem with science education was investigated at an earlier stage of schooling. However, statistics for higher education in the United Kingdom in 1992/1993 revealed a smaller number of undergraduate applications and admissions in sciences compared to those for arts and social sciences. According to the statistics (Higher Education Statistics Agency 1992/2993), applications for arts and social sciences were 17,700 and 23,500 respectively, whereas for science there were only 9,900. Therefore, it could be argued that the United Kingdom was correct to take corrective measures as early as the primary stage to remedy the situation.

The same phenomenon occurred in the United States of America in the 1970s. The National Assessment of Education Progress (NAEP) report, in the Third Assessment of Science, revealed that students' interest in science decreased between the third and seventh grades and still further between the seventh and eleventh grades (cited in Yager and Penick, 1983). It was also stated that student interest in a given course was lower at the end of the course than it was at the beginning. Feldman and Atkin (1993) also argue that only about 10% of US secondary school students elect for any science beyond the compulsory courses. Fewer still decide to major in science in universities. An even smaller number elect to pursue advanced degrees. This alarming state of science education has urged the US into a series of steps to carry out corrective measures and actions. It has introduced new curriculum programmes, made efforts to improve teacher education, has considered a national examination, and has stressed the development of standards and initiatives toward a voluntary national curriculum.



This similarity between the US and Malaysia shows again that the emphasis and importance given to science education is vital for the countries' development and progress even though the USA is a highly developed country compared to Malaysia, which is striving to become one. Just as the US wants its students to be first in world science and mathematics achievement by the year 2000, so Malaysia is trying to achieve the status of a scientific and progressive community by the year 2020. This shows that both countries have the same perceptions and attitudes towards the importance of school science in the education system.

This further supports the need for a study which takes primary science as an illustration of curriculum innovation and investigates teachers' understanding, perceptions, knowledge and thinking towards implementing the primary science curriculum.

## **2.2 Teachers and Teaching of Primary Science in Malaysia**

In the context of this study, there are some important issues from the teachers' perspective that will influence the implementation of the primary science curriculum. As many researchers in the curriculum implementation field have discovered (Nichols and Nichols 1975, Fullan and Pomfret 1977, Kimpston 1985, Carter and Hacker 1988), it is the teachers as agents of change who will determine the success or failure of an innovation (McNeil 1990, Marsh 1992, Williams and Williams 1994).

When a new programme is introduced, it is developed by innovators with their own terms of reference, and teachers are required to translate the new programme into the school context. Sometimes this may not match the innovators' ideas. Therefore, in

order to understand teachers' perspectives on an innovation, it is necessary to talk to the teachers themselves so that we can determine the meanings teachers give to innovation. As Olson (1980) argued, to understand how teachers construe their practice we need to develop ways of gaining access to their thinking.

The components that will be discussed in this section are teachers' perceptions of the nature of primary science teaching, teachers' selection of content, teachers' selection of teaching methods, teachers' perceptions on pupil development in science, teachers' perceptions of barriers to implementing the curriculum and teachers' ideology.

### ***2.2.1 Teachers' perceptions of the nature of primary science teaching***

In order to study the implementation of the Malaysian primary science curriculum, it is important to understand teachers' perceptions about the nature of primary science teaching. Teachers' perceptions will influence teachers' conceptions of science teaching and learning for primary school children, and will influence their decisions about the ways in which they organise their classrooms, their choice of strategies or activities, and their interactions with their pupils.

Primary science teachers in Malaysia are encouraged to apply the 'guided inquiry' approach in teaching science. Inquiry, according to Harlen (1999), 'has a variety of meanings such as learning which involves children learning actively — hands-on as opposed to book learning or it means active learning taking account of children's previous experience and ideas'. In this approach pupils are encouraged to raise questions and work independently to find answers. Therefore the essential skill pupils need for inquiry-based learning is that of asking questions. However, in the



Malaysian primary science context, inquiry is based on a guided approach.

Bonnstetter's (1998) model of a guided inquiry is that teachers still have the authority to select topics and questions, and provide the material but pupils are required to design the investigation, analyse the results and reach supportable conclusions.

The new primary science curriculum in Malaysia sees children as experimenters, discoverers and problem-solvers. A teacher in this new programme is a guide, counsellor and facilitator with a diminished authoritarian role. The teachers' new roles include making suggestions and asking questions as the children carry out the activities. This requires teachers to pay more attention to the students' thinking skills and scientific skills, including science process skills and manipulative skills.

Teachers are expected to provide children with relevant hands-on and minds-on activities. By comparison, the National Curriculum (1995) (NC) in England and Wales for science acknowledges the importance of both science processes (Sc.1) and science knowledge (Sc. 2-4); pupils may be involved in practical science activities with regard to both elements of the curriculum. These are:

- Sc. 1: Experimental and Investigative Science
- Sc. 2: Life Processes and Living Things
- Sc. 3: Materials and Properties
- Sc. 4: Physical Processes

Thus, a teacher's role in the NC for science is to develop children's ability to carry out investigations as specified by Sc. 1. Teachers need to identify learning outcomes clearly. Appropriate intervention strategies must be employed to help children achieve the desired outcomes. Teachers should also see themselves as a resource and feel free to impart certain knowledge and understanding to children, or to intervene

and ask children to clarify their ideas, explain procedures, etc. (Feasy 1993). There thus seem to be some significant similarities between the teachers' role in new KBSR science and in National Curriculum science. Both of these curricula highlight the need for teachers to emphasise activities and for children to be given more opportunity to investigate in the roles of experimenters, discoverers and problem-solvers.

The new KBSR science programme also requires teachers to develop an approach through which children construct their learning meaningfully. This makes it clear that the curriculum is not primarily about learning content, but it is a programme in which children are given learning tasks, materials and resources with which they interact with to construct their knowledge. This indicates that the approach to be taken by teachers is a constructivist one. To use such an approach (Scott, Dyson and Gater 1987, Harlen 1992, Shapiro 1994, Duit and Treagust 1995, Cross and Peet 1997) teachers must give priority to children's ideas. As Driver (1988) suggests, the key features which characterises this approach are:

- 1) *Learners are not viewed as passive but are seen as purposive and ultimately responsible for their own learning. They bring their prior conceptions to learning situations.*
- 2) *Learning is considered to involve an active process on the part of the learner. It involves the construction of meaning and often takes place through interpersonal negotiation.*
- 3) *Knowledge is not 'out there' but is personally and socially constructed, its status is problematic. It may be evaluated by the individuals in terms of the extent to which it 'fits' with their experiences and is coherent with other aspects of their knowledge.*
- 4) *Teachers bring along their prior conceptions of learning situations not only in terms of their subject knowledge but also their views of teaching and learning. These can influence their way of interacting in classroom*
- 5) *Teaching is not the transmission of knowledge but involves the organisation of the situations in the classroom and the design task in a way which promotes scientific learning*
- 6) *The curriculum is not that which is to be learned, but a programme of learning tasks, materials and resources from which students construct their knowledge (p.138)*



Thus, teachers become enablers for this process. They should interact with children's questions, promote challenges and experiences, and also offer new ways of thinking.

In this context, the teachers' role becomes that of:

- *encouraging the pupils to share and eventually own the purpose of the lesson or activity*
- *developing learning experiences that allow pupils to take responsibility for the design, process and outcomes of the investigation*
- *valuing pupil's hypothesis and conclusion and generating discussion of the scientific description of what has been taking place in the activity. (Watts 1991, p.64)*

The constructivist approach (Driver and Bell 1986, Driver and Oldham 1986, Needham 1987, Scott 1987, Cheung and Taylor 1991, Fensham, Gunstone and White 1994, Hawkins 1994, Hand and Treagust 1994, Appleton and Asoko 1996, McGuigan and Russel 1997, Murphy 1997, Appleton 1997, Watts 1998, Watts and Jofili 1998, Adam and Krockover 1999, Selley 1999, Leach and Scott 2000) offers an insight that is enormously valuable; it emphasises that the learner, during the learning process, necessarily reconstructs knowledge. Learning therefore occurs when there is a change in the learner's existing ideas, either by adding some new information or by reorganising what is already known (Driver and Oldham 1986, Driver and Bell 1986, Appleton 1997). We cannot teach a body of knowledge by direct transmission; the learner is always involved in reconstructing the meaning personally. The classroom activities suggested by the constructivists for eliciting, clarifying and reconstructing ideas become immensely valuable for the teacher who is monitoring and managing this reconstruction process (Millar 1989). Research done in Australia (Appleton 1997) on using a constructivist-based model for students' learning during science classes showed that when teachers focused on the learner and his/her responses, it helped the teachers to have pre-knowledge about

how students solve science problems during lessons. This helped teachers to use the appropriate teaching strategies.

In UK the SPACE (Science Processes and Concept Exploration) project was carried out to research primary children's ideas about science concepts. Its research phase, which revealed the nature and extent of different ideas, held by children across the whole range of concepts relevant at primary level. The methods for revealing children's ideas were of particular interest and encourage further research into children's ideas, much of it by teachers in their own classroom. The findings provide an account of idea children use to explain the scientific aspects of things around them and the way in which these ideas differ according to children's age and experience. They also reveal that the range of ideas is limited and shows marked similarities from one school to another (see SPACE research reports, 1990-1994).

The Nuffield Primary Science programme is firmly based on the findings from SPACE project. The project helped teachers by giving descriptions of what they were likely to find out if they explored the ideas of their children. Trial materials were also developed to help teachers plan activities, which take children's ideas as a starting point in classroom work. These activities were designed to help children to develop or to change their ideas through exploration bringing them closer to the more powerful ideas of science. The SPACE project, in its publications for teachers (the Nuffield Primary Science Teachers' Handbook, 1993) has suggested a range of strategies, including open questioning, asking children to draw and annotate their drawings, encouraging children to write or talk about their ideas and listening to



what children have to say. It was evident that these strategies provide opportunities for children to develop ideas.

*'So, by deliberately finding out the children's ideas, taking them seriously and choosing appropriate strategies for helping the children to test their ideas, the teacher moves children towards ideas which have wider application, fit evidence better, which are, in short, more scientific. Working in this way, children do the changing, rather than simply accepting ideas which they are told better; and they are advancing their skills and ways of relating ideas to evidence'*

(Nuffield Primary Science Teachers' Handbook, 1993 p.3)

Therefore the strategies for developing pupil's ideas is an important criteria in SPACE approach to science teaching - an approach in which children learn with understanding through the development of their own thinking. The constructivist view of teaching emphasises the importance in encouraging pupils to make their own ideas explicit and presenting the children with events, which challenge their ideas (Driver and Bell 1986). The SPACE project has showed that this has significance for teaching primary science.

Basically the constructivist approach is that pupils learn to investigate, not by being told how, but by trying out their own ideas. There has been evidence (see SPACE research reports 1990-1994) that pupils has existing ideas about scientific phenomena in the world around, even before they are exposed to related teaching. These ideas make sense to them because they are based on everyday experience. However these ideas often conflict with scientific view. Thus, constructivist teaching is seen as helping pupils' learning which change pupils' own ideas into ones consistence with the scientific view. Therefore, in the context of Malaysian primary science the view of constructivist teaching is important for teachers to know how to design activities to help children develop or to change their ideas through exploration taking them closer to the correct scientific view. Children develop ideas

they fully understand through their own thinking, therefore teachers must understand that they cannot do the thinking for the children nor can they obstruct the learning process by presenting the correct scientific view for children to learn.

It is the major aim of primary science education in the Malaysian context to give children the ability to think critically and creatively. To do this, teachers need to provide them with the experiences that enable them to form ideas that are meaningful to them and consistent with their experience. Therefore, in adopting such an approach, teachers particularly need knowledge and understanding of key ideas in science so that they can identify good starting points and know when children are closer to the scientific view or far away from it. Teachers must ensure that children encounter the experiences that will help them rethink their ideas.

In order to develop Malaysian younger generations who will be better thinker and becomes the future generation who will be able to make sounds decisions they need to be trained to do their own thinking. This could be achieved if majority of teachers teaching primary children value interaction with pupils closely in order to provide a range of meaningful experiences for pupils and help pupils to explicate and elaborate their own prior knowledge. The constructivist approach supports teachers in helping pupils understand science concepts meaningfully, instead of just memorising facts.

As pupils have a personal experience of concepts taught from activities and interactions, they will develop a better understanding of the science involved.

Therefore, teachers teaching science in the primary school must have an adequate



knowledge and understanding of this approach in order to carry it out in their respective classrooms.

### ***2.2.2 The objectives of the Malaysian primary science curriculum***

The objectives of the primary science curriculum, as stated in the official directives of the Malaysia Curriculum Development Centre (CDC) in 1993, are to give pupils an opportunity to:

- develop thinking skills in order to increase their intellectual capability
- develop scientific skills in an inquiring manner
- increase pupils' interests in the environment
- gain knowledge and understanding of scientific concepts and facts so helping them to understand themselves and their environment
- be able to solve problems as well as make responsible decisions
- cope with the latest contributions and innovations in science and technology
- practice and internalise good moral values and scientific attitudes in everyday life
- appreciate the contributions of science and technology to the well being of mankind.
- appreciate the orderliness of the universe.

The aims of primary science education, as stated by the CDC (1993b), are:

*'to produce pupils with knowledge, skills and good morals; to develop a community with a scientific and technological background, committed, dynamic and progressive; and to be more responsible towards the environment and able to appreciate the creation of the universe'. (p.2)*

Within the framework of the stated aims and objectives outlined by the CDC, an analysis of the teaching and learning needs of primary pupils in science can be made.

In developing pupils' thinking skills, teachers must understand that thinking is a process. This includes both knowledge and understanding in order to make an evaluation, make a decision or solve a problem. It involves interactions between knowledge, cognitive skills, attitudes and values.

The Malaysian curriculum developers have suggested that primary teachers focus on critical and creative thinking. Teachers must be able to differentiate these thinking skills in order to be able to develop them in their pupils. According to the CDC (1993b), a critical thinking skill is the ability to evaluate an idea, whereas a creative

thinking skill is the ability to use various approaches to solve problems and to produce original ideas. In order to solve problems and make decisions, pupils should use these thinking skills. The teaching and learning of science in primary schools should be planned and structured so that it develops and enhances pupils thinking skills.

According to Fisher (1990), creativity is something people use to make creative products. A creative idea or product is usually defined as being both original and appropriate. Creative products include works of art and scientific theories and also less tangible products such as inventive conversations and imaginative ideas.

Creativity is also a collection of attitudes and abilities that lead a person to produce creative thoughts, ideas or images. On the other hand, learning to think critically means: i. learning how to question, when to question and what to question ii.

learning how to reason, when to use reasoning and what reasoning method to use.

Fisher (ibid.) argues that a child can only think critically and reasonably to the extent that he is able, carefully, to examine experience, assess knowledge and ideas, and to weigh arguments before reaching a balanced judgement. He further suggests that being a critical thinker also consists of developing certain attitudes, such as a desire to reason, willingness to challenge and a passion for truth. He suggests that there is a relationship between creative and critical thinking:

*'Creative thinking is imaginative, inventive and involves the generation of new ideas. Every creative activity which seeks the solution to a problem requires the use of critical judgement, for creative ideas should not simply be novel but be of value. Creativity is not merely a question of generating new solutions to problems but creating better solutions. True creativity requires therefore the use of critical thinking.'* (p.64)



However, the CDC has produced guidelines to show how creative and critical thinking skills should be integrated in the primary science curriculum (see Figure 1).

The KBSR for science has produced a model for thinking skills as stated in module 3, a module developed by CDC for teachers of science. In this module, teachers are given a brief explanation of how to use the skills, what they are used for and examples of their use in a science lesson. For example, in discussing the critical thinking skill ‘compare and contrast’, it is explained that the skill is used when there are two or more attributes or possibilities and when options or decisions have to be made. Four steps are involved:

1. Observe one of two or more objects
2. Identify one attribute of the object
3. Determine whether the other object has the same attribute
4. State whether the attribute is similar or different

Example: Observe two leaves from different plants. Find their similarities and differences from both leaves. It is also suggested that teachers use a venn diagram to show the differences and similarities. (CDC, 1994c)

The KBSR primary science curriculum also states that the science process skills are mental processes that encourage pupils to find solutions to a problem and to make decisions systematically. Therefore, there is a strong relationship between thinking skills and science process skills, and the mastery of the latter should enhance the former.

In the primary science curriculum an emphasis is put on the mastery of science process skills. It is stated in module 2, developed by the CDC (1994b), that science process skills will involve the pupils in many activities and that will motivate them and increase their interest in science learning. The science process skills that are to be taught to primary school children are: observing, classifying, measuring and using

numbers, inferring, predicting, communicating, using space/time relationships, interpreting data, defining operationally, controlling variables, hypothesising and experimenting

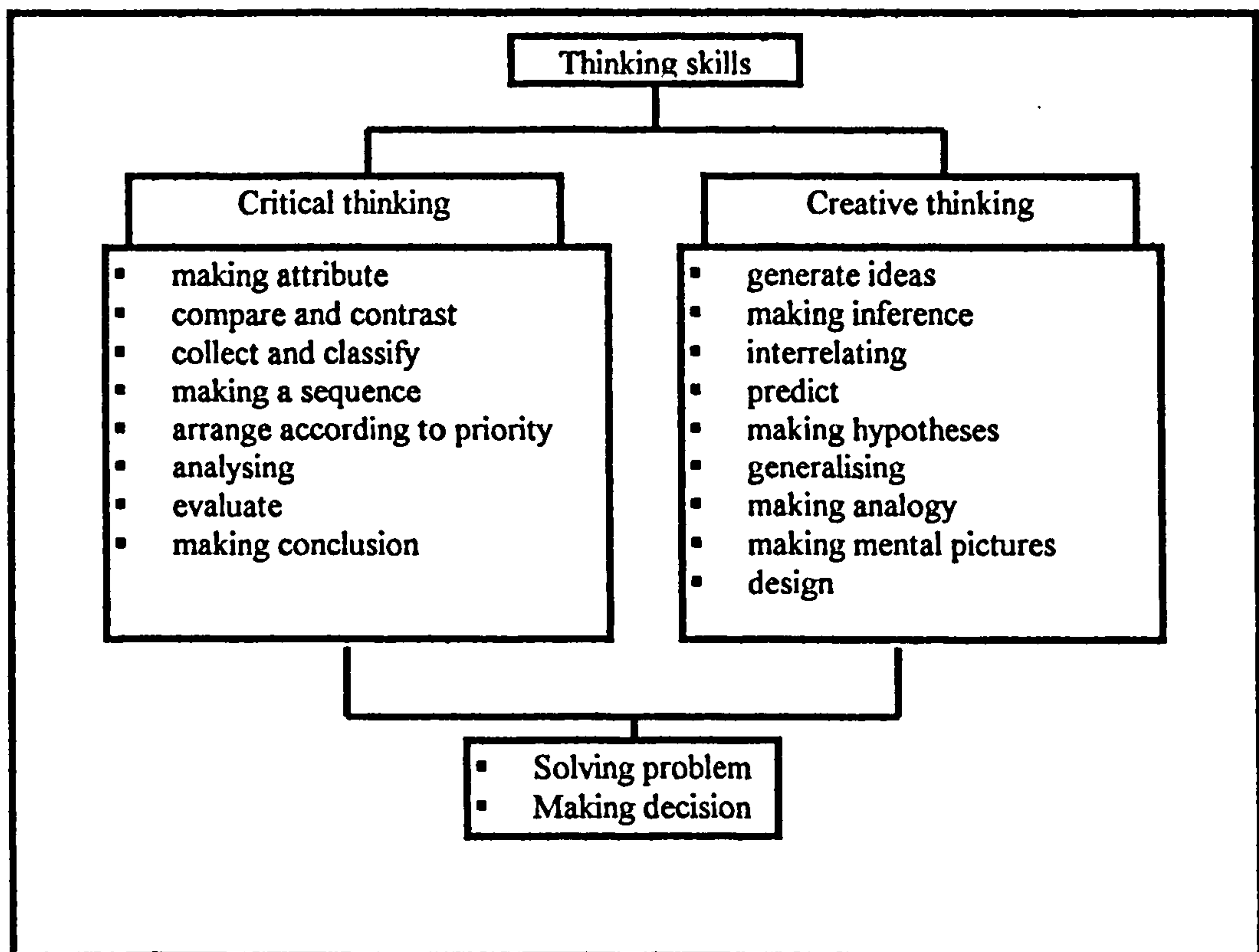


Figure 1-Thinking skills model for KBSR science  
(Source: Module 3 of the PuLSaR developed by CDC 1994c, p.4)

These skills are briefly explained in module 2, developed by the CDC:

- *Observing — Involves the use of sight, hearing, smell, taste and touch to gather information about objects and phenomenon. Sometimes observations also use quantitative measurement. It is not a process that can be done separately. It is a part of an investigation process that has aims. Even though it looks simple, to observe scientifically is a complex process. Concept knowledge cannot be separated from the scientific observation process because it guides selection and interpretation of the observation. The object or phenomenon observed should be an attribute that can be observed directly and not from past experiences.*
- *Classifying—Observe and identify similarities and differences between objects or phenomena and gather them based on similar attributes*
- *Measuring and using numbers—Making observation quantitatively using standard unit tools. Measurement is making the observation becomes accurate. Ability using numbers is important to master the measuring skill.*



- *Making Inference — An inference is making a pre-conclusion to explain events or objects based on observations. Usually past experiences are used as a base or guide to make the pre-conclusion. This pre-conclusion might be right or wrong.*
- *Prediction — Prediction is a process to determine and anticipate future events based on observations and past experiences or reliable data.*
- *Communication — Present ideas in a various forms such as speech, writing, graphs, diagrams, models or tables. It also includes the skill of listening to other people's ideas and reacting to them.*
- *Using space and time relationships — A process that explains or shows the location, direction, form and size of an object and its changes according to time.*
- *Interpreting information — This is a process that gives a rational explanation of objects, events, or patterns from the accumulated information. The information or data gathered are from a variety of formats*
- *Define operationally — This is giving a definition of a concept by stating things to do and observe. However, sometimes it is only an explanation.*
- *Controlling variable — In an investigation or a situation, there are a number of factors or variables that might influence the result of the investigation. Therefore, before an investigation is carried out, it is necessary to determine the relevant variables for the investigation. To look for the relation between two variables, one of them (manipulated/dependent variable) is varied to produce change in the second variable (responded variable/ independent). Other variables have to be standardised (controlled variables).*
- *Making hypotheses — This is a skill to make a general statement that is believed to be true in explaining an event or a phenomenon. However, the statement has to be tested to prove its validity. A statement from hypotheses is formed from questions emerging from the observation of situations.*
- *Experimenting — This is an investigation to test a hypothesis. The experimenting process includes all the processes mentioned above. The sequence of activities involved are:*
  1. *make observations*
  2. *formulate questions and make inferences*
  3. *form hypotheses to be tested*
  4. *control variables/ define operationally*
  5. *determine instruments to be used in the experiment*
  6. *carry out experiment, observe and record data*
  7. *analyse and interpret data observation*
  8. *draw a conclusion*
  9. *report the experiment's results*

By comparison, the National Curriculum in England and Wales for science in Sc. 1

for KS 1 and 2 (experimental and investigative science) has three components:

1. Planning experimental work
2. Obtaining evidence
3. Considering evidence

In planning experimental work, children should be taught to turn ideas suggested to them, and their own ideas, into a form that can be investigated. They should also be taught that thinking about what is expected to happen can be useful when planning what to do, and to recognise when a test or comparison is unfair. In the second component, obtaining evidence, children should be taught to explore the use of appropriate senses, to make observations and measurements, and to make a record of observations and measurements. In the third component, considering evidence, pupils should be taught to communicate what happened during their work, to use drawings, tables and bar charts to present results, to use results to draw conclusions, to indicate whether the evidence collected supports any predictions made, and to try to explain what they found out, drawing on their knowledge and understanding (DfE 1995).

Both curricula exhibit similarities in determining the science process skills to be acquired by children at primary level. However, the approaches are different. The fact is that science process skills are important elements in science education. When learners use existing ideas to attempt to make sense of new experiences and when their ideas change as a consequence, the outcome - the learning - depends on the way in which they process information, and how they select, gather and use it (Harlen 1993b). This shows that science process skills involve mental and physical skills that need to be mastered by children in order for learning to take place.

Another element that is specified in the KBSR is manipulative skills. These skills enable students to use and handle, store and clean scientific equipment and substances properly and safely, handle living and non-living specimens correctly and carefully, and sketch specimens, materials and equipment accurately. This element



can be seen in the National Curriculum in England and Wales for science under the Programme of Study component ‘health and safety’. This states that pupils should be given opportunities to recognise hazards and risks when working with living things and materials, and to follow simple instructions to control the risk.

In KBSR science, teachers are also required to inculcate positive attitudes and values among the pupils. Those that have been identified include:

- *show interest and curiosity towards their surroundings, honesty and accuracy in recording and validating data*
- *show flexibility and open-mindedness, perseverance in all tasks initiated*
- *be systematic and confident*
- *be co-operative, having responsibility for the safety of themselves and others*
- *care for fellow humans and the environment*
- *appreciate the contributions of science and technology*
- *be thankful to God for whatever blessings are given*
- *appreciate and practise a healthy and clean life style*
- *be aware that science is one of the ways to understand the universe* (CDC, 1993b)

As can be seen from an analysis of the objectives of the primary science curriculum, the CDC has explained only a few of the nine objectives and how they can be achieved. Moreover, a few objectives seem to be ambiguous and teachers might have problems in understanding and implementing them. For example, the objectives on ‘coping with the latest contributions and innovations in science and technology’, ‘appreciating the contributions of science and technology for the well being of mankind’, and ‘appreciating the orderliness of the universe’ are not explained.

Teachers do not always understand how they are to achieve these objectives in their teaching, with the result that the stated objectives of the CDC might not match the objectives achieved by teachers in their classrooms.

### ***2.2.3 Teachers' preliminary views on the objectives of the primary science curriculum***

Informal interviews with ten primary teachers in northern region in Malaysia were conducted in April 1998 to gain teachers' global views and understanding towards the primary science curriculum. A variety of responses emerged to the objectives of primary science education. Different teachers expressed different thoughts and views on these objectives.

Most teachers mentioned knowledge or the subject content of science as the main objective followed by 'giving pupils practical experience'. This implies that teachers attach a priority to imparting science concepts to the pupils as the main objective of the science curriculum.

A few teachers also mentioned the importance of developing an interest in science among the pupils so that they will pursue science in their secondary education and help the nation to achieve the "vision 2020". This implies that some teachers do have the aspiration that some of their pupils will eventually become scientists.

Other teachers said that an objective of the science curriculum is to develop science process skills among the pupils so that they will be able to apply these skills in their everyday lives. But when asked about these science process skills, some teachers also said that they themselves had difficulty in relating those skills to the pupils. This implies that teachers need help in developing their own scientific skills so that they can teach the same skills more effectively.

Another objective mentioned by a few teachers is 'to expose pupils to their environment, to help pupils communicate and to instil positive values in pupils'.

When asked how they expose their pupils to their environment, teachers gave



examples of topics in the 'Living World' where pupils conduct a range of experiments with living things such as mini-beast, plants etc. In this way pupils are engaged in their environment, and teachers said that during this activity pupils are involved in much discussion, which helps to instil scientific values and to enhance pupils' interests and curiosity towards their surroundings.

These informal interviews with teachers showed that they attach importance to science content, but no teacher listed thinking skills as the one of the objectives of the primary science curriculum, as required by the curriculum policy. Whenever teachers were asked about primary science education objectives, they seemed to hesitate and were unsure of their answers. Indeed, they seemed to be shocked by the question. This implies that teachers do not attach priority and importance to the objectives of science education. Comparing teachers' responses with the stated objectives in the mandated curriculum, it is clear that teachers' views on the objectives are based on, and are defined by, their own experiences in their classrooms.

The objectives mentioned by teachers are not global but reflect their individual teaching conditions. That is why every teacher only mentioned two or three objectives instead of the nine stated in the syllabus written by the CDC. This suggests teachers do not actually implement the innovation as required by the CDC.

Olson (1982) stated that what teachers do with an innovation can be interpreted as an accommodation between the various demands of the innovative doctrine of the teachers' work and the preferred solutions teachers have already adopted to cope with the demands of their work.

The informal interviews conducted with the teachers helped the researcher to develop some focused questions. The variety of responses from the teachers on how they view the objectives of primary science education raises doubts about the effectiveness of in-service courses and the curriculum guides provided by the CDC. It also shows how teachers' "professional craft knowledge" is used to help implement a new curriculum.

When the objectives of primary science, gained from these informal interviews, are considered, it seems that the teachers view the objectives according to their own experiences. Therefore, this raises questions regarding the effectiveness of the curriculum and the implementation of the curriculum at school level. There are nine stated objectives for the primary science curriculum; therefore, it is the intention of this study to find out how teachers view these objectives. Which of the objectives do they feel are the most important in teaching primary science and why, in relation to the pupils in their school? What are their views on the objectives as stated by the innovator or curriculum developer? On the basis of the teachers' views, it should be possible to relate the teachers' understanding of the curriculum objectives to the implemented objectives, because what is usually understood will influence actions. This will show whether the intended curriculum is realised in the classroom. This will be explored through the teachers' pedagogical content knowledge.

The informal interviews only touched on the understanding of the objectives of the primary science curriculum, and teachers seemed to have a variety of views and responses towards these objectives, probably due to them having their own perspectives based on different career levels and experiences. Hence, each teacher will have different beliefs and implicit theories about primary science objectives.

However, when talking to teachers, even though the informal interviews were about the objectives, some teachers brought up the problems of implementing the curriculum. For example, some were not very sure of the process skills involved in teaching primary science. Therefore, it is also important to explore the problems that the teachers might encounter during the implementation of the curriculum.

To summarise, this study seeks to find out and understand teachers' thoughts about their work, and through this analysis to understand more fully teachers' actions in the classroom. This should help clarify the implementation of the innovations in the primary science curriculum and determine whether the intended curriculum is, in fact, implemented in school.

#### ***2.2.4 The objectives of the Malaysian primary science curriculum - a personal view***

As a teacher trainer for the primary science education in teachers' college in Malaysia, I have been through the implementation of this new curriculum. The experience of teaching the curriculum can be considered as 'the trainer as a learner' since we are also implementing the curriculum as mandated. However, the experience gained helped give an insight and new perspective in understanding the curriculum through seminars and involvement with other related education department.

I believe the objectives of the Malaysian primary science curriculum for developing pupils studying science primary schools to be three fold. They are concerned with doing science, science applications and values in science.



**‘Doing Science’ involves pupils being helped to understand science by being engaged in doing. In this way, they will learn the main science concepts formerly taught in an abstract manner. When engaged in ‘doing science’ pupils will use their scientific skills, and this will enhance their competence and will also increase their thinking skills. Science concepts and skills are related and must not be taught in isolation. They will ultimately help pupils cope with problems encountered in their everyday lives. Through activity, pupils will be able to develop an understanding of what is involved in ‘doing science’. This will encourage them to learn science through what is termed ‘hands-on’ and ‘minds-on’ activities, which are based on the process of inquiry learning. The activities will increase motivation by stimulating curiosity and will aid the development of pupils at the concrete stage of cognitive development. The need to understand science, with its implication for developing powers of explanation and of practical capability, is of direct significance for future specialists. This is one of the nation’s main aspirations in the ‘vision 2020’ to produce a ‘scientific generation’.**

**The second aim is for pupils to know about the applications of science, including the contribution of technology towards life. It is important for pupils to have an awareness and appreciation of technology as part of their lives in the modern world. Technology, as an applied science, has now become established in many countries. Therefore, teachers should be able to provide their pupils with knowledge related to technology. For example, in classroom settings the computer is becoming a significant aid in the teaching and learning processes. Hence teachers should be literate in ICT (Information and Communication Technology) as models for their pupils in the appreciation of technology.**

The third aim is to develop values in pupils. The scientific values that teachers can instil in their pupils include being

- a) interested and satisfying pupil curiosity in the environment
- b) honest and accurate in recording and verifying data
- c) flexible and open minded, able to accept challenge
- d) systematic and confident
- e) co-operative and responsible for the safety of others, the environment and himself
- f) caring
- g) appreciative of the contribution of science and technology
- h) appreciative of God's gift
- i) appreciative of, and able to practice a healthy and hygienic way of life
- j) aware that science is one of the ways to understand the universe (CDC, 1993b)

However, the attitudes that teachers should emphasise more are those which have particular relevance to science. These include: curiosity, respect for evidence, open-mindedness, flexibility, critical reflection, and sensitivity to living things and to environment. Scientific attitudes should be instilled as early as possible so that the developing generation will become trustworthy and responsible scientists, engineers, doctors, etc.

The objectives of primary science education in Malaysia can be summarised as: equipping children with the scientific knowledge they need to interpret and make sense of everyday experiences, with positive attitudes towards science, and with scientific literacy and scientific skills. Scientific skills can be developed through various modes of enquiry, and in particular this will enhance pupils' thinking skills as an essential cognitive toolkit for modern life. The last, but not least, objective is to produce scientists and technicians that are essential for the economic vitality of the nation.

The objectives of the Malaysian primary science curriculum are appropriate for school science education *provided the teachers themselves understand these objectives*. By understanding and internalising the objectives, the teachers will be

able to implement the curriculum as intended by the curriculum innovators. As mentioned above, the curriculum objectives can be looked at from three different perspectives: doing science, science applications and values in science. Doing science will have the greatest effect on the learner and will help to produce the scientific generation needed by the nation. This is the main component of the present research - the impact of the teachers' understanding and thinking on the implementation of the curriculum. We wish to argue that if teachers understand and are able to internalise the objectives of the primary science curriculum, they will be able to teach science effectively. Thus, we seek to identify teachers' beliefs, values and attitudes towards primary science education, since these components are central to the process of curriculum implementation. Teachers use their beliefs (their preconceptions and implicit theories) to make decisions and guide their behaviour. Therefore, this will largely determine whether, the curriculum innovation is implemented or not.

As for 'doing science', we relate this to the perceptions teachers hold on how children learn science, how they recognise the value of children's ideas, the process skills used in science and the thinking skills that the children should be developing. Therefore, this study stressed the importance of exploring Malaysian primary teachers' knowledge which includes their subject content knowledge (competency in the subject matter), their science pedagogical knowledge - especially their knowledge on inquiry teaching and their understanding and perceptions of the constructivist approach. Their knowledge about learners in the science classroom will also be explored so as to understand their thinking of learner characteristics in a science lesson. This inevitably affects the awareness of the application of science



being developed by the pupils. Therefore, we include an analysis of teachers' understanding of their pupils' characteristics in a science class as well as the values and scientific attitudes held by the pupils. The study is based on the belief that, through examining teachers' knowledge in primary science education, the implementation of curriculum innovation can be better understood.

We also intend to consider the problems or barriers the teachers themselves face in implementing the curriculum. In Malaysia, when an innovation is to be implemented, teachers attended courses supervised by the district education department and conducted by key personnel (who are themselves teachers but are selected by the district education office according to certain criteria). Courses are taught mainly through lectures; therefore teachers only receive the information and are then expected to implement the curriculum as mandated. Afterwards the teachers themselves disseminate the knowledge to their colleagues teaching science in school, and this is done in an informal way. This raises questions about the effectiveness of science teaching, even by experienced teachers.

### **2.3 The Present Study**

The Malaysian primary science curriculum was hurriedly implemented in December 1994 (as discussed in 1.3). Many curriculum innovations seem to be unsuccessful, and there are many contributing factors towards this outcome (see, for example: Morris 1985, Prophet and Rowell 1993, Saez and Carretero 1998, Tabulawa 1998). In the Malaysian context, several authors have reported on curriculum innovations. They generally reveal that the curriculum innovations have been unsuccessful. For example, Noor Azmi (1988) found that in-service courses for teachers to help

implement innovation have only a surface impact, and, he argues, it is teachers' sense of professionalism that determines if they are willing to change their attitudes. Sharifah Maimunah and Lewin (1991) argue that there is a gap between the planners and developers and the teachers as implementers of change. They suggest that the developers are high-level professionals who are highly motivated, above-average teachers compared with primary teachers, who have a low level of professional development and commitment. This implies that it is the teachers' responsibility to ensure that an innovation is successful. Blenkin *et al.* (1992) write that:

*'The current policy of creating and establishing a National Curriculum for England and Wales is predicated on a deficit view of the teaching profession. The implementation of that policy is conceived, planned and carried out by instruction and dictation to teachers - much of it from non-professional sources. It cannot be seen as a policy which will raise teachers' view of themselves, either individually or collectively, despite the rhetoric. And it is difficult to understand how anyone can reasonably expect to bring about improvement in a system by a process of down grading, demoralising or deskillling its practitioners.'* (p.103)

This is similar to the situation in Malaysia, where the policy has always been planned at a central level to be implemented by teachers at the periphery, corresponding to the centre-periphery model of innovation. Teachers are expected to implement the curriculum as instructed and mandated. Fullan (1993) argues that mandated educational policies are not sufficient for teachers, and educational mandates mean only that educational goals will have less impact in an innovation. He suggests that the creation of the conditions for people to have a personal, and shared vision and for skill development through practice would have a positive impact on innovation. Malaysia's curriculum policy is a mandated policy and teachers have to implement it once it is published. This is the case with the primary science curriculum.

Problems that arise during innovation are often linked to the teachers as well as the implementers. It is teachers who will play an important role in making decisions

about the curriculum, teaching and learning. Therefore teachers have autonomy to make decisions in the classroom. They are the most important change agents in implementing an innovation. Many studies have found that innovations were not implemented successfully by teachers (see for example; Morris 1985, Prophet and Rowell 1993, Saez and Carretero 1998, Tabulawa 1998). The implication is that teachers themselves are barriers to innovation. Does this mean that teachers do not use the autonomy that they have? Brown and McIntyre (cited in Olson, 1982) state that teachers value autonomy but want personal support when trying new ideas which tend to conflict with, and create dilemmas in, their practice. The dilemmas that teachers have to cope with arise when the new innovation upsets their comfortable and stable methods of teaching and their pupils' learning environment. This phenomenon suggests that there is a discrepancy between the intended and implemented curriculum in the classroom. This thesis aims to determine the fate of Malaysia's new primary science curriculum and its implementation in schools. In Malaysia, generally, the intended curriculum is the curriculum proposed by the curriculum developer or innovators without reference to the practicalities of the classroom. Brown and McIntyre (1993) argue that teachers realise that proposed innovation usually takes little account of familiar and comfortable classroom practices that must be changed. For some reason, certain innovations are practical, while others are not.

The quality of primary science education will depend above all on the teachers' content knowledge, practical knowledge and skills. According to Bishop and Denly (1997),

*'Pedagogical content knowledge is a useful concept that all science teachers need. It involves knowledge about the kinds of misconception and alternative ideas that*



*pupils bring with them to science lessons; about the range of strategies and activities which can be employed to identify and remedy them; and the relationship between procedural and conceptual understanding'. (p.38)*

Bishop and Denly adapt Calderhead's (1987) pedagogical content knowledge for science teachers into six components:

- knowledge of the curriculum
- knowledge of learners
- knowledge of educational aims
- knowledge of general pedagogy
- knowledge of other content
- knowledge of the subject matter

The integration of these components of knowledge should help enormously in the teaching and learning of science. This knowledge is very important for effective teaching; it is a teacher's professional knowledge, which can only be acquired through experience and motivation over time.

Therefore teachers need help in acquiring this knowledge and this could be given through in-service education and training (INSET). As discussed in Chapter 1 (section 1.9) the short in-service courses given to teachers has shown ineffective for teachers to implement the curriculum. This is reported by the Inspectorate of Schools, Malaysian Ministry of Education. This suggests that the INSET particularly for primary science education need to use different strategies from the previous one. There was no classroom support given to teachers from the INSET thus, teachers implement the curriculum as how they understand it. Harvey (1999) proposes a synthesis model for the phasing of science INSET after experiencing implementing and evaluating Primary Science Programme INSET in Madadeni in South Africa. One of his recommendations is 'consideration of phasing the pedagogical process of

professional learning will be separate from consideration of the goals of INSET that are appropriate to each stages of development'. This phasing model, include:

- the security phase (first year - focusing on subject knowledge- workshops, classroom supports and committee activities),
- the methods phase (second year - focusing on internalising new generalisable teaching methods- workshops, classroom supports and committee activities),
- the aims phase (third year - teachers assume greater control over the aims of the project- workshops, classroom supports and committee activities).

The recommendation indicate that for an INSET to be effective it has to be long term and has to use a gradual approach for the development of the process of professional learning. Harvey (1999) stresses that the sequence proposed is ideal thus monitoring progress and judging the timing of progression from one phase to the next is for the implementers and the teachers to judge together. However, it can be seen that the model emphasises the classroom support to be phase for the teachers to develop their pedagogical process of professional learning.

Therefore the CDC in Malaysia might want to design an INSET for primary science teachers that emphasise classroom support in ensuring implementation of new methods. If supports are given while teachers are practising the new skills on the job it would be more effective for teachers' understanding of the practice of new teaching methods as Harvey (1999) suggests could be develop in the methods phase.

### ***2.3.1 Teachers' selection of content***

In order to understand how teachers select the content of the primary science curriculum, there are a number of aspects that need to be discussed. Schmidt *et al.*



(1987) argue that even if there is a District or State specification of content, teachers may still consciously or overtly choose content different from that specification, or interpret the policy so as to be consistent with their own content choices. This is, however, misleading in the context of Malaysian primary schools because it is the practice in Malaysia for teachers to follow closely the specified content set by the CDC because they are afraid of being accused or blamed for not covering the syllabus as directed. It is the intention of this study to investigate teachers' curriculum decisions concerning the content specified by CDC. Therefore, to understand teachers' curriculum decisions, we must examine the factors that the teachers themselves take into consideration. These include a teacher's own beliefs about the subject matter, previous educational influences and the characteristics of the pupils. All of these can be grouped as teachers' professional craft knowledge, teachers' personal knowledge and teachers' practical knowledge.

Shulman (1986) proposes that effective teachers have three kinds of knowledge: knowledge about the subject matter they are teaching (subject matter), knowledge of general instructional strategies (pedagogical knowledge), and knowledge of specific strategies for teaching particular subjects (pedagogical content knowledge). The most important of these is the pedagogical content knowledge that will enable teachers to relate, and make connections between, the knowledge of pedagogy and the knowledge of content - their professional understanding. Shulman (1986) states that when teachers make decisions about their teaching and the content of their courses, they have to use many types of knowledge. This includes the content knowledge of a subject i.e. an understanding of the facts and concepts of a certain domain and also a grasp of the structures of the subject matter. With this knowledge,



teachers not only understand that something is so; but they also understand why it is so (Shulman 1986).

Shulman (1987) further suggests that there are seven categories of the knowledge base of teachers:

- content knowledge
- general pedagogical knowledge, with special reference to those broad principles and strategies of classroom management and organisation that appear to transcend subject matter
- curriculum knowledge, with a particular grasp of the materials and programmes that serves as 'tools of the trade' for the teachers
- pedagogical content knowledge, that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding
- knowledge of learners and their characteristics
- knowledge of educational contexts, ranging from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures and
- knowledge of educational ends, purposes and values and their philosophical and historical grounding

(p.8)

It can be seen that Shulman (1987) lists teachers' content knowledge as a first priority in teachers knowledge base. This implies that teachers' knowledge of subject matter affects both the content and process of instruction. It influences both what teachers teach and how they teach it (Grossman *et al.* 1989) Therefore, this study seeks to explore teachers' pedagogical knowledge through their content knowledge and their science pedagogical knowledge.

### **2.3.2 Teachers' selection of teaching methods**

Shulman (1986) proposes that to be effective, teachers must have three kinds of knowledge: knowledge about the subject matter they are teaching, i.e. the content knowledge; knowledge of general instructional strategies, i.e. the pedagogical knowledge; and knowledge of specific strategies for teaching a certain subject, i.e. the pedagogical content knowledge. The emphasis is put on the pedagogical content knowledge, since that this knowledge enables practising teachers to make

connections between their knowledge of pedagogy and their knowledge of content. This connection is critical for teaching effectiveness. Thus, teachers must have a strong knowledge base and personal understanding of the subject matter in order to transfer knowledge to their students. In doing so, teachers must be adept in ways of transforming the subject matter so as to enhance its development in the minds of their pupils.

This is vitally important in the Malaysian context of primary school science. As mentioned earlier, a majority of the teachers presently teaching science in the primary school attended the five-day orientation course of the new syllabus and they then implemented the curriculum, as mandated, in their schools. With the limited knowledge gained in through short-term exposure to the new curriculum, we must question the effectiveness of teachers of science. Wilson, Shulman and Ritchert (1987) argue that teachers must understand not only certain concepts but also the ways of representing these concepts to the students in order to enhance learning. This reflects the importance of the pedagogical knowledge teachers should have in order to represent their ideas to the students and to choose appropriate teaching strategies. Teachers' pedagogical knowledge will determine whether the activities pupils carry out are interesting and can motivate them to continue studying science in the future. Thus, in the Malaysian context, it is the teachers' responsibility to be aware of this and to develop their professional expertise with this in mind.

In Malaysia, the primary science curriculum emphasises that teachers should use a constructivist and guided inquiry approaches when representing the science concepts to their pupils.

The curriculum developers also specified the teaching strategies that can be used by Malaysian primary teachers. The suggested strategies are: experiment, discussion, simulation and project. However, it is also stated that teachers should consider all approaches to the curriculum. This includes activity-based learning, which integrates knowledge acquisition with skill mastery, as well as the inculcation of moral values and scientific attitudes. Teachers are reminded to advocate experiential learning with, an emphasis on an inquiry approach. This means that, generally, the children will be questioning, searching for information, and investigating.

Wilson, Shulman, Rithert (1987) observe:

*'In addition to general pedagogical and subject matter knowledge our model includes pedagogical content knowledge. This knowledge includes an understanding of what it means to teach a particular topic as well as knowledge of the principles and techniques required to do so. Framed by a conceptualisation of subject matter for teaching, teachers hold knowledge about how to teach the subject, how learners learn the subject (what are subject-specific difficulties in learning, what are the developmental capabilities of students for acquiring particular concepts, what are common misconception), how curricular materials are organised in the subject area, and how particular topics are best included in the curriculum.'* (p.118)

Therefore, in order to implement curriculum innovation, it is important for the Malaysian primary school teachers of science to have appropriate pedagogical content knowledge if they are to teach the subject effectively. This includes knowing how to select the best teaching method for their pupils' various abilities and how to use the curriculum material effectively. Hence, by using this model, this study on the implementation of the primary science curriculum in Malaysian schools will examine teachers' pedagogical content knowledge.

By using Shulman's pedagogical content knowledge framework, we seek to analyse the Malaysian primary school teachers' thinking on implementing the primary science curriculum. McEwan (cited in Grossman *et al.*, 1989) suggests that in order



for teachers to construct a sound pedagogical knowledge interpretation, they must possess accurate knowledge of their students and beliefs about the subject. These beliefs include student preconceptions and misconceptions as well as students' prior knowledge and experience of a subject. This implies that teachers' selection of teaching methods is related to their pedagogical content knowledge, including their beliefs about the subject and also the students' characteristics. This will be discussed in the following section.

### **2.3.3 *Pupils' scientific development***

A teacher's view of how learning take place in science lessons will influence the teaching and learning processes in her/his class. This view will determine his/her role in science lessons and the role the pupil is expected to take, the experience and material he/she will provide and what strategies or activities are to be used.

Therefore, it is important for teachers to understand how children learn science in order to promote effective science learning among their pupils.

Children first learn science when they form a meaningful understanding of the input they receive through their senses. Meaningful learning occurs when pupils' prior knowledge interrelates with sensory input. In other words, the existing ideas are used to explain the new experience (Harlen 1992, 1993a, 1996). Children should not be treated as 'tabula rasa'; their understanding of what they see and hear will be based on their existing or prior knowledge. This knowledge will influence the development of their new ideas. According to Fensham (cited in Gilbert *et al.*, 1982), the 'tabula rasa' approach assumes that the learner has no knowledge of a topic before being formally taught it. The assumption is that the learner's 'blank mind' can be filled

with teacher's science. According to the alternative view of how pupils learn science, teachers should plan their teaching in such a way that the pupils are given a continuous sensory input so that meaningful learning will occur. They can do this by providing opportunities for pupils to use science process skills and manipulative skills during activity-based learning, which emphasises 'minds-on' and 'hands-on' involvement. For example, in fieldwork for the topic on living things, children are to classify plants according to their characteristics. The 'hands-on' activity requires children to observe the physical characteristic of a few small plants, to draw and measure the plants' size, and to investigate leaves, stems, roots, flowers and fruits. They can also be encouraged to make comparison between the plants. The 'minds-on' activity is where the children are given different types of leaves and they are asked to discuss in a group the characteristics they will use to make a classification on the leaves. Thus, by providing 'hands-on' and 'minds-on' activities, children's learning outcomes are meaningful. Teachers should be aware that meaningful learning will not occur if input is only didactic.

Pupils' science development is based on children having existing ideas, perceptions and beliefs arising from their previous learning experiences, and these existing ideas are strong and resistant to change (Driver and Oldham 1986). Thus, if teachers only talk about the scientists' view of science concepts, children's existing ideas will be resistant to change. With this in mind, teachers should plan pupil-centred activities to encourage active discussion among children in order to elicit their ideas. They should use an effective questioning technique (Harlen 1993b) in order to encourage children to speak of their ideas and so develop their critical and creative thinking skills (Fisher 1990). When children communicate and take an active part in learning,

they can generate and explain their own ideas, challenge these ideas and those of their peers and above all they can develop a strong understanding of science concepts. McGuigan and Schilling (1997) state that the view of the learner as being actively involved in the learning process has major implications for the teachers' role. Teachers need to consider how children's ideas might best be elicited in a classroom context and how they might appropriately respond to children's ideas as they emerge. This will test the teacher's knowledge of the nature of the pupils' progress within different areas of understanding in science, and will confirm the importance of the understanding of the subject matter (content knowledge).

The last perspective is that of children's learning styles. Children learn in various ways depending on their needs and interests. They have different learning styles because each has different perceptions, and so they respond in different ways. Some children can learn individually whereas others learn best in a group. Some children think convergently while others think divergently. For example, pupils who think convergently can only fully understand science concepts when teachers give them activities organised in series so that through these activities the ideas or concepts will be focussed and thus understood. On the other hand, pupils who think divergently can understand science concepts extensively because this type of thinker can use a critical, analytical and rational approach to develop an understanding from one science concept to another, and they can deduce relationships between two or more concepts.

These views will require teachers to use various teaching strategies and approaches to cater for the diverse needs and styles of learning among the children. In addition, this will increase interest in science learning. Teachers have to equip themselves



with a variety of teaching and learning strategies. Some of the characteristics that teachers should have in mind when planning their science lessons are as follows:

- flexible classroom organisations
- a variety of teaching and learning methods
- opportunities for children to plan and implement their own learning activities
- child-centred learning
- opportunities for children to reflect
- evaluate and share their learning experiences
- learning in small groups

Teachers can use these as guides in planning their lessons, so that children will have a strong foundation and positive development in science. These perceptions of children's learning development in science will guide teachers in managing the learning and teaching processes within the primary science curriculum.

## **2.4 Teachers' Perceptions of Barriers to Implementation of Curriculum Innovation**

Marsh (1991) states that the questions that teachers often think of when faced with the prospect of implementing a new curriculum are: "how do I do it?", "will I ever get it to work smoothly?", "to whom can I turn to get assistance?", "am I doing what is required?", "will I cover the syllabus?", "what is the effect on the learner?", "will the students pass the relevant examination?". As these questions are formulated in teachers' minds, teachers will have to make decisions about whether and how an innovation is implemented. Teachers will consider many factors before making any decision.

Doyle and Ponder (1977) argue that teachers assess an innovation from the viewpoint of 'pragmatic scepticism', which gives priority and primary concern to the practicality of the innovation. Teachers assess whether an innovation is practical with reference to three criteria — instrumentality, congruence and cost. Is the

innovation instrumental in terms of classroom contingencies? Is it congruent with prevailing conditions? What are the costs involved in using the innovation?

Therefore, for the innovation to be implemented successfully, the teachers' decision is crucial. The practicality of the innovation and the preparedness of the teachers are the main concerns in the implementation of an innovation. Hence, whatever teachers perceive to be barriers to the implementation of an innovation will influence their decision.

However, the concern of this study is the analysis of the factors which teachers perceive as having an influence on them when implementing the curriculum. The factors that will be analysed in the context of this innovation are the teachers themselves. That is, we need to consider what are their reactions towards the curriculum, the resources that are required or provided for the innovation, their classroom management expertise and the support that they received, for example from the school administration, colleagues, the Headteacher, the District Education Department and in-service courses.

Even though these are the key factors there are others that the teachers might consider. Morris (1985) found that teachers mentioned more than one factor as an influence on their decision not to implement pedagogic innovation. The factors identified were teachers themselves, teacher skills/training, the ability of pupils, the language skills of pupils and /or teachers, the pupil, the school principal and colleagues. These finding revealed the importance of viewing innovation in the context of influences on teachers' decisions, which include social and institutional influences as well as the 'distinctive ecology of the classroom' (Doyle and Ponder 1977).



## **2.5 Teachers' Thinking**

The most important focus of this study is on understanding teachers' thinking about the implementation of the primary science curriculum. The study seeks to understand how teachers use their professional craft knowledge to explain the objectives of the curriculum, and how they explain the meaning they attach towards the teaching and learning process in their classrooms. To describe and interpret teachers thinking on the objectives of the curriculum, the researcher assumes that it is related to, and depends on, teachers' knowledge. This assumption is based on the evidence of findings from research on teachers' knowledge. Some of this has focused on the pedagogical content knowledge held by teachers. Gudmundsdottir (1991), for example, studied the pedagogical content knowledge of an expert English teacher and how this knowledge influenced other categories in the teacher's knowledge base. Gudmundsdottir (1991) found that the teacher's pedagogical model is central to the teacher's pedagogical content knowledge and knowledge base. It influenced other categories in the knowledge base, such as the teacher's knowledge of learners. For example, Gudmonsdottir (1991) found that the teacher sees learners through a lens provided by the teacher's model and perceived how reluctant readers, whom the teacher needs to teach how to read and interpret literature, sought evidence in the text itself. Other research has focused on teachers' knowledge related to the content being taught. Chen and Ennis (1995) studied the subject-pedagogical content knowledge transformation process associated with the teachers' curricular-decision making in secondary physical education. Their findings indicate that teachers personalise pedagogical content knowledge even though they share a common subject-content knowledge base. This suggests that teachers' pedagogical



content knowledge is personally constructed. Grossman *et al.* (1989), suggest that teachers' subject matter knowledge affects both the content and processes of instruction, influencing both what teachers teach and how they teach it. One of the examples given in their discussion is that of an English teacher teaching grammar who raced through a review of homework, avoiding eye contact with the students she thought might ask difficult questions. This lesson was in contrast to this same teacher's style in teaching literature, which she knew well; in literature, she emphasised open discussions and welcomed student questions and comments. Haes (1986) categorises teachers thinking into four categories. One of them is 'knowledge as transacted in the curriculum'. Haes found that responses from teachers support the view that conceptions of knowledge are a potent influence on opinions about the curriculum and on curricular practice, and he concluded that knowledge does effect teachers' curricular practice. Such research indicates that there are many areas to investigate in trying to understand the process of teaching.

Experienced teachers' knowledge has been developed and structured through the process of reflection and practical problem-solving that they engage in to carry out the demands of their job. This knowledge is informed by each teacher's individual way of thinking and knowing and is also influenced by his/her beliefs, attitudes and values (Schmidt and Buckman 1983, Fraser, Tobin and Lacy 1988, Smith and Neale 1989, Wallace and Loudon 1992). For example, in Fraser, Tobin and Lacy (1988) study of exemplary primary science teachers found that these teachers give positive findings on classroom management, material-centred learning and classroom interactions. The findings also highlight the importance of teachers'

knowledge, beliefs about learning and teaching, and values in determining what is taught and how activities are implemented. .

### **2.5.1 Teachers' ideology**

The teachers' working environment is seen as complex and fluid, since teachers deal with human beings who are complex living organisms. The nature of this environment requires teachers to make on-the-spot decisions, and this explains their reliance on intuition and impulse leading to instantaneous responses. These experiences contribute to teachers' 'practical knowledge', that is, those beliefs, insight, and habits that enable them to do their work in school (Feiman-Nemser and Floden 1986). Therefore, for an individual teacher the mixture of beliefs, insights, and habits, together with values and attitudes, are important components of their role and of the dynamics of teaching and learning. However, these components do not help teachers' progress in the teaching and learning process if they have a high workload, if they are subjected to excess pressures during the school day and they experience a reduction of pleasure in teaching (Campbell *et al.* 1991). The authors argue that the introduction of the National Curriculum and assessments increased teachers' workloads. Most teachers saw their work with a corrosive and debilitating sense of low morale, frustration, and unattractive lengthy administrative burdens, and, furthermore, teachers perceived that the vigour, enthusiasm and liveliness which they had previously brought to their work was being damaged. Teachers also perceived that the workloads were damaging to their personal life and relationships with their friends and families (Campbell *et al.* 1991)



In the context of the Malaysian new KBSR program, it is not known how teachers perceive their workloads. However, it is a major innovation and as in other curriculum innovations, there tend to be new elements to be implemented, thereby increasing teachers' workloads. For example, in science, new KBSR teachers are required to administer an evaluation of each individual pupil's process science skills. Even though this evaluation is done during classroom science activities, teachers still have to evaluate all the specified science process skills for each individual pupil in their class of about 40 pupils. This implies that teachers will face tensions and stress in implementing this assessment requirement because they will have to provide these pupil assessment results to the state examination board before the pupils' National Examination in September. For example, in 1997, this evaluation had to be carried out between February and July. However, it is not the intention of this study to investigate teachers' workloads but to explore teachers' ideology.

In this study, the examination of teachers' ideology will focus on teachers' beliefs, values and attitudes within science education. A science education programme is incomplete if it neglects any of the following: concern for scientific knowledge (certain facts, principles and theories worth knowing), a concern for the processes and methods of science (reasoning and investigating), direct experience of scientific activity, appreciation of the complex relationship between science and society, and the fostering of positive attitudes towards science (Hodson 1985). Therefore teachers' beliefs, values and attitudes will be related to these components in science education and, in particular, primary science education.

Teachers' beliefs greatly influence their decisions on teaching and learning processes. Teachers' beliefs in science education are influenced by their philosophy



of science education. According to Loose (cited in Hodson 1985), the philosophy of science is concerned with four basic questions: 1. What characteristics distinguish scientific inquiry from other types of investigations? 2. What procedures should scientists follow in investigating nature? 3. What conditions must be satisfied for a scientific explanation to be correct? 4. What is the cognitive status of scientific laws and principles? These components develop and form teachers' philosophies of science education. Teachers' beliefs impact on the practices they undertake in their classrooms; therefore their beliefs on the philosophy of science education will influence their decision to accept or reject the objectives, methods and approaches in the innovation of the primary science curriculum.

This study will also look at the values that teachers hold towards the teaching of primary science. In this context, teachers' values will be related to the principles they apply in educating their pupils in science. If the teachers' principle aim is to educate their pupils, then they will be committed to provide experiences for their pupils to be successful and confident in science. If teachers value the importance of the individuality of their pupils, then they will be committed to the evaluation of pupils' creativity and potential and they will acknowledge and appreciate the pupils' ideas and knowledge in science.

The study of teachers' attitudes will focus on two aspects: teachers' attitudes towards primary science as a subject and teachers' interest and commitment towards the teaching of science. These aspects have a strong relationship with, and influence on, teachers' confidence in their own understanding and content knowledge (subject matter knowledge) of primary science.

## **2.6 The Research Questions**

Teachers' preliminary views help to focus this study to find out and understand teachers' thoughts about their work, and through this analysis to understand more fully teachers' actions in the classroom. This should help clarify the implementation of the innovations in the primary science curriculum and determine whether the intended curriculum is, in fact, implemented in school.

Therefore the preliminary interviews informed the main research questions that will be used to study the curriculum implementation are as follows:

1. Does the implementation of the Primary Science Curriculum match the intended curriculum developed by the curriculum innovators?
  - a. What are teachers' perceptions and understanding of the objectives of the primary science curriculum and their own perceptions (thinking) of the stated objectives in the programme?
  - b. To what extent does teachers' Pedagogical Content Knowledge (PCK) help them implement the primary science curriculum?:
    - i. To what extent do the perceptions' teachers hold correspond with the nature of primary science teaching suggested by the curriculum?
    - ii. To what extent does teachers' science pedagogical knowledge help them to implement the curriculum? (Include teaching methods, classroom organisation, science resources)
    - iii. To what extent does teachers' knowledge about learning characteristics in science help them to implement the curriculum?
    - iv. To what extent does teachers' content knowledge help them in implementing the curriculum?
2. What are teachers' perceptions of the barriers to the implementation of the primary science curriculum?
3. To what extent do teachers' values, beliefs and attitudes influence the implementation of the primary science curriculum?



## Chapter 3 RESEARCH METHODOLOGY

### 3.1 Introduction

This is a case study of the implementation of the Malaysian primary science curriculum. It is hoped that the findings will enhance the researcher's own knowledge of the innovation and will be of interest to the Malaysian Ministry of Education. Since the researcher is attached to a teacher training college, she will use the findings to improve the course for training teachers for the primary science programme. This will enable the Teacher Education Division to revise the programme for science trainees. With this modified curriculum, the hope is that the problems faced and mistakes made by teachers in the past will not be repeated by newly qualified teachers, thereby ensuring quality improvement of primary science education in Malaysia.

Case study techniques were chosen to examine teachers' thinking about the implementation of the primary science curriculum. As Sturman (1997) observes:

*' "Case study" is a generic term for the investigation of an individual, group, or phenomenon.*

*While the techniques used in the investigation may be varied, and may include both qualitative and quantitative approaches, the distinguishing feature of a case study is the belief that human systems develop a characteristic wholeness or integrity and are not simply a loose collection of traits. As a consequence of this belief, case study researchers hold that to understand a case, to explain or predict from a single example, requires an in-depth investigation of the interdependencies of parts and of the patterns that emerge.'* (p.61)

The case in this study is the implementation of a curriculum innovation in Malaysia — the primary science curriculum — and in order to understand this case, an in-depth investigation to explain and predict the patterns emerging from the study was undertaken. It is generally agreed (Nisbet and Watt 1978, Sommer and Sommer 1980, Robson 1993) that case studies are appropriate strategies for research involving an in-depth empirical investigation of a contemporary phenomenon, and



that it can involve units as small as an individual or as large as an entire community or region. It provides the opportunity to apply a multi-method approach to a unique event or setting. In this study, the phenomenon or unique event to be explored is the primary science curriculum innovation in terms of whether it has been successfully implemented as intended. The case study involves both a group of teachers and region-wide study. It was felt that, by using a case study and in-depth investigation, it would be possible to explain, describe and interpret the innovation from the teachers' perspectives. Sommer and Sommer (1980) suggest that:

*'Educational researchers employ the technique to study innovations. Unlike before-and after measurement, which examines changes on an objective test at two points in time, the case study focuses on the process of change with attention to the role that individuals play in promoting/hindering a new program. For example, a case study may reveal that the innovation failed because it was imposed arbitrarily on key individuals who refused to support it, not because of its form or content.'* (p.196)

Thus, the intention of the researcher is to focus on the role that primary teachers play in promoting or hindering the new science curriculum. It was decided to combine qualitative and quantitative methods in this study, as a multi-method approach, in order to strengthen the findings. As Stenhouse (1988) observes:

*'Case study methods involve the collection and recording of data about a case or cases, and the preparation of a report or a representation of the case. The collection of data on site is termed "fieldwork" and it involves: (a) generally, participant or non-participant observation and interviewing; (b) probably, the collection of documentary evidence and descriptive statistics, and the administration of tests or questionnaires; and (c) possibly, the use of photography, motion pictures, or videotape recording.'* (p.49)

Therefore, the fieldwork in this study involves non-participant observation, recorded interviewing and the administration of questionnaires as a multi-method approach to collecting and recording data about the implementation of curriculum innovation in primary science in Malaysia. It was important for the researcher to be a non-participant observer. As Cohen and Manion (1994) point out, the researcher stands aloof from the group activities they are investigating - in this case the teachers of

primary science and their use of pedagogical content knowledge to help them implement the curriculum. It was felt that, by adopting the role of non-participant observer, it should be possible to observe a number of components of teachers' pedagogical content knowledge as they implemented the curriculum. According to Merriam (1988), a case study can also include data gathered by a survey instrument (e.g. questionnaires). Therefore, in this study questionnaires were developed and analysed quantitatively using statistical methods. McMillan and Schumacher (1989) state that quantitative research presents statistical results represented by numbers whereas qualitative research presents facts in a narration with words. They further argue that:

*'Traditional qualitative research is also distinguished by using case study design, in which a single 'case' is studied in depth. This could be an individual, one group of students, a school, a program or a concept. The purpose is to understand the person(s) or phenomenon. Since qualitative design investigates behaviour as it occurs naturally in non-contrived situations there is no manipulation of conditions or experience.'* (p.36)

Therefore, the implementation of the primary science curriculum will also be investigated by analysing the knowledge (thinking) of a group of teachers presently teaching the subject. Denzin and Lincoln (1994) argue that both qualitative and quantitative research is concerned with individual points of view, but they add:

*'Qualitative investigators think that they can get closer to the actor's perspective through detailed interviewing and observations. They argue that quantitative researchers seldom are able to capture the subject's perspective because they have to rely on more remote, inferential empirical materials. The empirical materials produced by the softer, interpretative methods are regarded by many quantitative researchers as unreliable, impressionistic and not objective.'* (p.5)

Even though this statement refers to those preferring one type of method, it is the intention of this study to combine both. It is suggested that with a combination of methods the success or failure of the implementation of the primary science curriculum will be exposed since both methods focus on individual points of view. By using quantitative methods, the views of a sample of teachers should represent



the views of the population of teachers nation-wide. The qualitative methods will explore, in-depth, a group of teachers' views on the implementation of the curriculum, and this should allow a closer perspective of the 'actors' and the meanings teachers give to their actions.

## **3.2 Research Design**

### ***3.2.1 Case study***

The qualitative aspects of the research involve using case study techniques. Guba and Lincoln (cited in Merriam, 1988) outline the advantages of case study in that it provides 'thick description, is grounded, is holistic and lifelike, simplifies data to be considered by the reader, illuminates meaning and communicate tacit knowledge'.

Ross (1988) states that a 'thick description' indicates the meaning of behaviour, and the clarification of meaning, which is sought in an interpretation of the social meaning of classroom events. Therefore, 'thick description' provides the information necessary to make informed judgements about the degree and extent of the particular cases of interest.

Brown and McIntyre (1993) suggest that ethnographical and case study approaches can be used in research in order to gain access to teachers' professional craft knowledge. Bromley (cited in Merriam, 1988) state that case studies, by definition, 'get as close to the subject of interest as they possibly can, partly by means of direct observation in natural settings, partly by their access to subjective factors (thoughts, feelings and desire)'. Hence, this study seeks to unfold and probe the structures of teachers' thinking in their knowledge, beliefs, values and attitudes through interviews and observation.



For this study the researcher uses the teachers' pedagogical content knowledge (PCK) framework (Shulman, 1986). The PCK can be divided into four categories: teachers' content knowledge in the subject, teachers' knowledge of learners' characteristics in science classrooms, teachers' general pedagogical knowledge (teachers' strategies on organisation and management of science rooms), and teachers' knowledge of the science curriculum (teaching strategies in science, resources, materials). Another key aspect concerns the problems or barriers that teachers face in implementing the curriculum. This study also attempts to find out whether teachers' beliefs, values and attitudes have any influence on the implementation of the curriculum.

### ***3.2.2 Triangulation***

According to Cohen and Manion (1994), triangulation is a technique to explain more fully the richness and complexity of human behaviour by studying it from more than one standpoint i.e. by making use of both quantitative and qualitative data. Denzin (cited in Cohen and Manion, 1994) terms this as 'methodological triangulation', which he identifies as 'within methods' and 'between methods' triangulation. In the context of this study, triangulation between methods is applied, since it involves the use of more than one method in the pursuit of one phenomenon (i.e. primary science curriculum implementation). Stake (1994) also observes that triangulation is generally considered a process of using multiple perceptions to clarify meaning, by verifying the repeatability of an observation or interpretation.

### ***3.2.3 The questionnaire***

One aim of the study is to focus on teachers' knowledge in implementing the primary science curriculum in Malaysia. This involves examining teachers' understanding and perception of the objectives of the primary science curriculum. This was done qualitatively and quantitatively. Teachers were interviewed about their perceptions of the objectives. For quantitative measurements, a questionnaire was developed. A questionnaire is a self-report instrument used for gathering information about variables of interest to an investigator (Wolf 1998). Therefore, by using a questionnaire, it was hoped to gather information on teachers' perceptions and use these data in a triangulation (Cohen and Manion 1994) with the interviews to be carried out in the case study. According to McMillan and Schumacher (1989) the questionnaire approach is relatively economical and assures anonymity of the respondents. Wilson and McClean (1994) suggest that the questionnaire offers one of the simplest forms of gathering information. Therefore, it was believed that by using this method, it would be possible to gather information on the curriculum implementation from a larger sample, and that this would help in the interpretation of the results. It was decided to use the mail or self-completion type of questionnaire. As May (1997) points out, this offers a relatively cheap method of data collection compared to the personal interview. For an individual researcher, it is not possible to gather a lot of information by personal interviews. However, a small group of teachers were interviewed.

### ***3.2.4 Interview***

In order to explore teachers' pedagogical content knowledge, an interview approach is used in this study. Through interviews the researcher can gain access to peoples'



subjective understanding, that is the meanings people attach to experience and how this affects the way they behave (Seidman 1991). Furthermore, Cohen and Manion (1989) state that through interviews the researcher is able to probe peoples' thinking, i.e. their knowledge, values, preferences, attitudes and beliefs and ways of thinking. Therefore, interviews were used to unfold and probe deeply into teachers' knowledge, values, attitudes and beliefs in relation to the implementation of the primary science curriculum. The interviews were tape recorded and transcribed. Interview is one of the most common and most powerful methods we can use to understand our fellow human beings. The researcher hoped to understand teachers' tacit knowledge, and this knowledge can only be gathered through interviews, where teachers explain the meanings they attach to the actions that they have taken in their classrooms. Teachers' voices can be heard and appreciated using this method, and the researcher can compare the reality with the curriculum guidelines to see whether teachers implement the intended curriculum. Much of the research done in the field of curriculum and teachers' knowledge has used the interview as a method of inquiry (Dobey and Schafer 1984, Smith and Neale 1989, Hand and Treagust 1994, Appleton 1995, Chen and Ennis 1995). This implies that interviewing is a very useful tool for understanding the meanings that teachers give to their actions, i.e. what they think when they perform an action.

### ***3.2.5 Classroom observation***

Classroom teaching was observed in order to determine teachers' pedagogical content knowledge (in terms of the four categories mentioned earlier). Merriam (1988) suggests that observation makes it possible to record behaviour as it is happening. This implies that it is possible for the researcher to be able to observe the



activity in the teacher's classroom firsthand. The situation in the classroom, the teacher's behaviour, and events that are occurring during the observation can be recorded, and a subsequent interview, after the lesson, can help to clarify events and understand them; with the added benefit of the teacher's perceptions and reasons for so doing. This is an advantage because the researcher can study what occurs in real situations as opposed to highly contrived or artificial settings (McMillan and Schumacher 1989). The observations carried out focused on the teachers' pedagogical content knowledge. The aspects considered were:

- a) content in the science syllabus (subject matter);
- b) learners' characteristics in science classrooms;
- c) general pedagogical knowledge (teachers' strategies for the organisation and management of the science room);
- d) the implementation of the science curriculum (teaching strategies in science, resources, materials).

Table 3.0 presents a summary of the method carried out in this study.

Research Question	Teachers knowledge on	Questionnaire	Interviews	Observations
1	<b>a. Primary Science Objectives</b>	/	/	
	<b>b. content</b>		/	/
	<b>c. learner characteristic</b>			
	<b>i. behaviour</b>	/	/	/
	<b>ii. knowledge, skills and scientific attitudes</b>	/	/	/
	<b>d. general pedagogy</b>	/	/	
	<b>e. science pedagogy</b>			
	<b>i. strategies, resources, etc</b>	/	/	/
	<b>ii. constructivist approach</b>	/	/	/
2	<b>Problems (barriers)</b>	/	/	
3	<b>Beliefs, attitudes, and values</b>	/	/	

Table 3.0 Techniques applied in the case study

### 3.2.6 Justification of the research design

The method of inquiry is a combination of qualitative and quantitative methods. The qualitative data were gathered from interviews and observations. Denzin and Lincoln (1994) argue that:



*'Qualitative research is multi-method in focus, involving an interpretative, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural setting, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. Qualitative research involves the studied use and collection of a variety of empirical materials - case study, personal experience, introspective, life story, interview, observational, historical, interactional and visual texts - that describe routine and problematic moments and meanings in individuals lives. Accordingly, qualitative researchers deploy a wide range of interconnected methods, hoping always to get a better fix on the subject matter at hand.'* (p.2)

In this study of the implementation of a curriculum innovation, it is the intention to explore and investigate how teachers perceive and respond to the curriculum guidelines. This can only be done in the teachers' natural settings, their classrooms. By observing and interviewing teachers about the events in their classrooms, the researcher hoped to be able to describe the routines, the problematic moments and meanings in the teachers' individual lives in implementing the curriculum. By using the observation method, the context of observation can be described in a rich and holistic manner. The natural sequence of events is preserved, unpredicted events can be reported, and a qualitative statement can be made (Stallings and Mohlman 1988). Therefore, the researcher used classroom observation to focus on teachers' content knowledge, teachers' perception of the pupils' characteristics in their science classes, and teachers' use of strategies and resources during their science lessons. Through this classroom observation, it was hoped that the Malaysian primary teachers' science teaching routines, problematic moments and meanings they give to the curriculum would emerge and be understood better when the teachers were subsequently interviewed.

As already explained, this study is a combination method: the researcher also used a quantitative method in a small part of the study. The method of inquiry was the questionnaire, which focused on the areas mentioned above. The reason for adding this method of data collection was to gather more information from a bigger sample

of primary school teachers in Malaysia so that a wider range of views could be analysed. Moreover the results from questionnaires can be used as a triangulation to strengthen the findings from the qualitative data. As Denzin (1988) argues:

*'Each research method implies a different interpretation of the world and suggests a different line of action the observer may take towards the research process. The meanings of methods are constantly changing, and each investigator brings different interpretations to bear upon the very research methods that are utilised. For those reasons, the most fruitful search for sound interpretation of the real world must rely upon triangulation strategies. Interpretations which are built upon triangulation are certain to be stronger than those which rest on the more constricted framework of a single method.'* (p.512)

Therefore, it was felt that using multiple methods to study the same phenomena would help to overcome the intrinsic bias from a single method of investigation and enable a stronger interpretation of the research finding. However, even though a quantitative method is also used, the focus of the study is on the teachers' cognition, and this was investigated qualitatively.

In the context of this study, teachers' knowledge of subject matter was investigated through classroom observation followed by an interview to discuss the lesson and the teachers' explanation of their planning, teaching and reflection on the lesson. This was compared with the mandated syllabus to find out any discrepancy between the intended and the implemented curriculum.

Teachers' knowledge of learners' characteristics in science was determined by observations, interviews and questionnaires. The interviews, conducted after the observed lesson, focused on the teachers' understanding of the learners' characteristics or behaviour in the science classroom. Interviews were semi-structured, depending on the classroom situation and environment during observation. Teachers' understanding of the knowledge, skills and scientific attitudes children should have at the end of their primary science education was examined by questionnaires.



Teachers’ levels of general pedagogical knowledge were elicited from interviews, which focused on the strategies teachers used for the organisation and management of their science rooms. Teachers’ knowledge of the primary school science curriculum was studied through both interviews and observation. The interviews focused on teachers’ understanding of the strategies or approaches in teaching science and why they use them. They were also interviewed on the resources, classroom management and teacher-pupil relationship in their science classes. Questions were also developed on teachers’ understanding of the constructivist approach, scientific skills and scientific attitude, and the problems teachers’ faced in implementing the curriculum. A summary of the categories investigated by the questionnaires is shown in Table 3.1.

CATEGORIES	NO OF ITEMS	ORIGIN
1. About teachers and their science background	10 items	
2(A) Objectives of primary science curriculum		Malaysian Curriculum Development Centre 1993b (CDC)
a. importance of the objectives	9 items	
b. teachers' ranking of the objectives	1 item	
(B) open-ended questions	4 items	
3. Teaching strategies		adapted from Yager (1991)  researcher researcher and adapted from evaluation of implementation of science in the National Curriculum (England and Wales)
a. as suggested by the constructivist approach	10 items	
b. roles teacher plays in science lessons	1 item	
c. open-ended questions	4 items	
4. Science Resources		Evaluation of implementation of science in the National Curriculum (England and Wales)
a. books, science equipment and the science room	3 items	
b. open-ended question	3 items	
5. Organising pupils in science classes		Adopted from evaluation of implementation of science in the National Curriculum (England and Wales)
a. how teachers organise pupils	4 items	
b. open-ended question	2 items	
6. Pupils' characteristics		Malaysian CDC 1993b
a. importance of each skill	12 items	
b. three most important skills	1 item	
7. Barriers/problems in implementing the curriculum	15 items	Adopted from Taylor <i>et al.</i> (1974)
8. Teachers ideology: beliefs, attitudes and values	12 items	adapted from evaluation of implementation of science in the National Curriculum (England and Wales)
Total Number	91 items	

Table 3.1 Categories investigated by the questionnaire (pilot)

Semi-structured interviews were also used and followed the same categories as the questionnaire but they probed in depth how teachers cope with, and tackle,



problems. The aim was to find out teachers’ personal views and ideology on the primary science curriculum. The list of questions asked included:

- (i) beliefs – teachers’ role in implementing the curriculum innovation
- (ii) values - the values they hold towards teaching primary science and implementing the curriculum
- (iii) attitudes - teachers’ attitudes towards the subject of science and teaching science

In the researcher’s view, a semi-structured interview is suitable for this type of questioning because it should enable her to probe deeper into the teachers’ personal feelings and views on the issues. McMillan and Schumacher (1989) state that questions phrased in a semi-structured interview allow for individual responses and are open-ended but fairly specific in their intent. Open-ended questions help the researcher to ask for clarification and explanation from the respondents, and this provides a deeper understanding of teachers’ thinking towards the implementation of the curriculum. According to Bogdan and Biklen (1992),

*‘in order to capture the subjects’ own words and let the analysis emerge, interview schedules and observation guides generally allow for open-ended responses and are flexible enough for the observer to note and collect data on unexpected dimensions of the topic.’ (p.77).*

Table 3.2 shows the categories included in the interview.

CATEGORIES	QUESTIONS
A. Teachers’ perceptions of the nature of primary science teaching	1. What role do you play in your science lesson? 2. What type of teaching approaches do you use in your class? 3. Who controls learning in your science lesson? 4. What is your view of how children learn? 5. What are your thoughts about constructivist teaching/learning approaches? 6. What is your opinion of the importance of the students’ active participation in learning your own class? 7. What is your opinion of the idea that students are ‘active learners’?
B. Teachers’ perceptions of the objectives of primary science education	1. What is your opinion on the objectives of primary science education? 2. Referring to the nine stated objectives of primary science, how would you rank them? 3. Which of the objectives do you find easy to implement (and why)? 4. Which of the objectives do you find difficult to implement (and why)? 5. Which of the objectives do you find difficult to understand? 6. Given the chance, what would you like the objectives of the primary science education to be.
C. Teachers’ selection of content (depends on classroom observation)	1. When you select the content to teach, what are the main factors that influence you? 2. How do you know whether the content/knowledge that you want to transfer to the pupils is adequate or correct?
D. Teachers’ selection of methods (depends on classroom observation)	1. What is your opinion about the inquiry approach in teaching science? 2. How do you find the use of this approach in your own science class? 3. Can you explain why you use the strategy that you choose in teaching the content?

CATEGORIES	QUESTIONS
E. Pupil development in science (depends on classroom observation)	<ol style="list-style-type: none"> <li>1. How do you develop your pupils' scientific skills?</li> <li>2. How do you develop your pupils' scientific values?</li> <li>3. What were the scientific skills and values that you instilled in this lesson?</li> <li>4. Could you explain how you instilled the scientific skills and values in this lesson?</li> <li>5. What is your opinion about considering children's ideas in teaching science?</li> <li>6. How did you consider the children's ideas in your lesson?</li> </ol>
F. Teachers' perceptions of the barriers to the implementation of the curriculum	<ol style="list-style-type: none"> <li>a. Self <ol style="list-style-type: none"> <li>1. How would you compare the teaching of science in the new curriculum with the old one?</li> <li>2. Which curriculum do you feel comfortable with and why?</li> <li>3. What is your opinion on the implementation of primary science in the new KBSR?</li> </ol> </li> <li>b. Resources <ol style="list-style-type: none"> <li>4. How would you compare the teaching of science in the new curriculum with the old one?</li> <li>5. Which curriculum do you feel comfortable with (and why)?</li> </ol> </li> <li>c. Support <ol style="list-style-type: none"> <li>6. What are the supports do you receive in implementing the primary science curriculum from: <ol style="list-style-type: none"> <li>a. Headteacher, b. Colleague, c. District Education Officer, d. Teacher Activity Centre?</li> </ol> </li> </ol> </li> <li>d. Classroom management <ol style="list-style-type: none"> <li>7. How would you explain the organisation of your pupils in your classroom?</li> <li>8. Why do you organise the pupils in your science lesson in this way?</li> </ol> </li> </ol>
G. Teachers' ideology	<ol style="list-style-type: none"> <li>a. Beliefs <ol style="list-style-type: none"> <li>1. What is your opinion of the characteristics of scientific enquiry?</li> <li>2. How would you explain the procedures that the scientist should follow in investigating nature?</li> <li>3. How would you explain the conditions that must be satisfied before a scientific explanation can be correct?</li> </ol> </li> <li>b. Values <ol style="list-style-type: none"> <li>4. What is your opinion about the best ways to educate our pupils in science?</li> </ol> </li> <li>c. Attitudes <ol style="list-style-type: none"> <li>5. What are your opinions and feelings about primary science?</li> <li>6. What are your opinions and feelings about the teaching of primary science?</li> </ol> </li> </ol>

Table 3.2 Questions included in semi-structured interview

### 3.3 Other Possible Methods

There are other approaches that could be used to carry out this study. One is videotape recording. Leinhardt (1988) states that research on teachers' thinking has used video taping to provide an unbiased record and act as a stimulus to produce data for future analysis. As the purpose of this study is to understand teachers' tacit knowledge, they could be videotaped for the whole period of a classroom lesson. The tape could be analysed for key points regarding the objectives of the lesson, the learners' behaviour in the classroom, and other decisions and events that occurred during the lesson. The tape could be played back to the teacher after the lesson and he/she can be questioned with respect to his/her thoughts during the activity



sequence. The responses to these questions could then be analysed. Clark and Peterson (1986), in their analysis of teachers' thought processes identify twelve studies (Morrine and Vallance 1975, Marland 1977, Semmel 1977, McNair 1978, Conners 1978, Peterson and Clark 1978, Lowyck 1980, Wodlinger 1980, Shroyer, 1981, Colker 1982, Forgaty, Wang and Creek 1982 and Housner and Griffey 1983) in which researchers used videotape during lessons to study teachers' interactive thoughts and decisions. Generally, in these studies teachers were videotaped during their lessons and the video was used in a stimulated recall interview technique in a different format for each study. Teachers' responses to the interview were also audio-taped and coded to categorise teachers' statement or thoughts. However, according to Leinhardt (1988), there are some important issues to consider when using videotape, and these are related to the techniques of use. The researcher must identify the entrance into the setting. Usually when a teacher starts a class, students will take some time to settle down; therefore the researcher has to determine when to start videotaping. There is also the time frame of the videotape segment. A videotape reel will have a finite length, and if lessons in class also take a similar time, then the researcher might not capture events occurring after the time limit. The audio and visual points of focus will also restrict the researcher in capturing the whole class situation. The researcher might only focus on the teacher and not on the students. If the researcher focuses on students, it can only be on an individual or a group. This will misrepresent the whole class situation. When people are recorded their behaviour might change; thus the video representation of a lesson has significant disadvantages.

Another possible approach is the Repertory Grid Technique. Duffy, Olson and Munby (cited in Clark and Peterson, 1988) used this method of inquiry to identify teachers' implicit theories. Basically, the technique involves rating, on a grid, between an 'elements' axis (Kelly's term) - people situations, etc.- and a 'construct' axis - ways in which the subjects think about the 'elements'. These may be elicited during an interview or otherwise supplied by the interviewer. Generally, the completed grid is analysed factorially to determine the relationships among constructs (Munby, 1984). The strength of using this method of inquiry in research dealing with teachers' thinking is that the domain of interest is the individual teachers' own interest. By using this method, special attention is given to individual teachers' needs and opportunities to talk about their implicit theories, such as their beliefs and principles. However, teachers' beliefs and principles will not be understood if a designed instrument for measuring teachers' beliefs and principle is used. A designed instrument will usually contain test items developed by the test developer. Therefore the test items are the various beliefs of interest of the developer, and these might not necessarily correspond to the beliefs of the individual teachers within a unique professional environment. Munby (1984) concludes that the method can obtain the particular knowledge about a teachers beliefs and principles within a context determined by the teacher. This implies that knowledge on teachers' beliefs and principles in implementing curriculum could help us to understand why teachers implement or reject curriculum innovation. On the other hand, this method can only be used for a small number of respondents in the context of a nation-wide curriculum implementation. Munby (1984), in his study of teacher's beliefs, conducted a case study of one teacher. Olson used 8 subjects, Duffy used 8 teachers,



and Munby used 14 teachers (cited in Clark and Peterson, 1986) in their studies using the repertory grid technique. Although these studies were related to the implementation of a new curriculum, the number of subjects was quite small to represent the entire population of teachers carrying out the implementation curriculum innovation. Thus, it would not be possible to apply this technique to study teachers' nation-wide implementation of a new curriculum. Furthermore, this method of inquiry is time-consuming if bigger samples of respondents are used, since teachers' constructs need to be elicited during interviews.

Another further methods that can be used is 'interview about instances' or 'interview about events' (Osborne and Gilberg, 1980). This method can probe teachers' understanding on certain topics within the subject. This technique was used by Kruger and Summers (1988) in their study of primary school teachers' understanding of science concepts, and by Harlen and Holroyd (1997) in their study of primary science teachers' understanding of concepts of science and their impact on confidence and teaching. Basically, interviews were based on events, objects or photographs relating to the science concepts being investigated. One of the weaknesses of this method is that teachers might feel anxious and inadequate when they are asked a question they cannot answer. They might also feel that the interviewer was trying to expose their weaknesses, mistakes in teaching concepts or giving provision of wrong information to students. On the other hand, as Harlen and Holroyd (1997) suggest, the interview can succeed as 'collaborative explanation', with the teachers feeling satisfied and pleased that something that they had not previously understood now makes sense. This implies that teachers' confidence might increase, thereby benefiting the teaching and learning processes.



In the context of this study, the researcher rejected the above techniques. Even though there are strengths in these methods, it was felt that they were not suitable and appropriate for the Malaysian setting. For example, if the researcher used the 'interview about instances' and 'interview about events' technique, teachers would not be willing to participate in the study because this method would be regarded, in Malaysia, as an attempt to teachers' weaknesses and inadequacies. As the researcher has a lot of experience in the Malaysian primary system, she felt that this method would not result in any co-operation from the teachers nor help her to get an overview of the nation-wide curriculum implementation process. Nor was it possible to use the repertory grid technique. Even though the intention was to interview a group of teachers, it was also to observe their teaching in order to investigate whether teachers implemented the curriculum as intended. The repertory grid technique would only examine teachers' beliefs and principles. The use of videotape and the simulated recall technique were also rejected. The researcher felt that the teachers would not be acting naturally with a video-recorder in front of them. Thus, to reduce bias it was felt appropriate to use a paper and pencil method to collect the data.

The chosen method of inquiry was thought to be 'non threatening' to the teachers in Malaysia. As a local with an understanding of the culture, the researcher knows that teachers do not like to be given any test or questions that might degrade their dignity as teachers. By using qualitative methods and by promoting the concept of the researcher as learner, she hoped to gain access to teachers' tacit knowledge.

### 3.4 The Research Samples

This study uses two types of sample, the probability sample and the non-probability sample. The survey sample comes from the probability sample and the case study sample is the non-probability sample. In the probability sample the probability of selection of respondents is known, and in the non-probability samples it is unknown (Cohen and Manion 1994). The survey sample (probability sample) was taken from seven of the 14 states in Malaysia. The schools selected are National Schools only because the language used in the survey is Malay. The method of selecting the subjects was by systematic sampling (McMillan and Schumacher 1989, Cohen and Manion 1994). From a population list of schools in each state, every  $n^{\text{th}}$  of the school was selected. This depends on the number of schools in each state. For example, in Melaka there is a population of 130 schools and a sample of 26 (20%) schools was required, so every 5<sup>th</sup> school on the list was chosen. For each school selected, two teachers were asked to complete the questionnaire. The sample for the case study was a non-probability sample. According to Cohen and Manion (1994):

*'Small-scale surveys often resort to the use of non-probability samples. Despite the disadvantages that arise from their non-representativeness, they are far less complicated to set up, are considerably less expensive, and can prove perfectly adequate where researchers do not intend to generalise their findings beyond the sample in question or where they are simply piloting a survey questionnaire as a prelude to their main study.'* (p.88)

In this case study it was intended to use 14 teachers of primary science working within 25 km of the researcher's base. The sampling was a purposive one based on researcher judgement of the teachers typicality from their involvement with the in-service courses provided by the Ministry of Education. As McMillan and Schumacher (1989) put it, purposeful sampling is a strategy to choose small groups or individuals likely to be knowledgeable and informative about the phenomenon of



interest. In the context of this study the teachers identified are those who have had experience teaching primary science since its implementation. Thus they are assumed to be knowledgeable and informative about the implementation of the curriculum. Table 3.3 summarises the training backgrounds of the teachers.

<i>Schools selected</i>	<i>Teacher Female(F)/ Male(M)</i>	<i>Primary Science Course attended and option during teacher training programme</i>	<i>Science background until secondary level</i>
School A.	Mansor (MA)-M	Orientation course – 5 days Malay Study Programme	General science (arts stream)
School A	Soraya(SO)-F	14 weeks in-service course English Study Programme	Pure science (science stream)
School B	Zarina (ZA)-F	14weeks in-service course Malay Study Programme	Pure science (science stream)
School B	Juliza(JZ)-F	Orientation course – 5 days Malay Study Programme	General science (arts stream)
School C	Dzamani (DZ)-M	14 weeks in-service course Malay Study Programme	General science (arts stream)
School C	Norizah (NH)-F	Orientation course – 5 days Malay Study Programme	Pure science (science stream)
School D	Shafie (SS)-M	Orientation course – 5 days Malay Study Programme	General science (arts stream)
School D	Nurul (NU)-F	14 weeks in-service course Malay Study Programme	Pure science (science stream)
School E	Muyidin (MY)-F (key personnel)	Orientation course – 8 days Science and Mathematics Programme	Pure science (science stream)
School F	Badriah (BA)-F	Orientation course – 5 days Mathematics Programme	Pure science (science stream)
School F	Ruhil (RU)-F	Orientation course - 5 days Malay Study Programme	Pure science (science stream)
School G	Aminah (AA)-F	Orientation course – 5 days Malay Study Programme	Pure science (science stream)
School H	Sharifah (SH)-F	Orientation course – 5 days Malay Study Programme	Pure science (science stream)
School I	Norbadriah (NB)-F	14 weeks in-service course Malay Study Programme	General science (arts stream)

Table 3.3 Selected teachers' training and science backgrounds (the names used are pseudonyms)

## 3.5 Into the Field

### 3.5.1 Data collection

Data for this study were collected and interpreted through two levels of inquiry: (i) the questionnaire and (ii) interviews and classroom observations. The questionnaires were adapted from previous research (Taylor *et al.* 1974 and Russell, Qualter and McGuigan 1994), and informal interviews were carried out in April 1998 to determine teachers' global views on the primary science curriculum and to



understand their perceptions of the curriculum to implement it (discussed in section 2.2.3). The questionnaire was developed and then translated into Bahasa Malaysia with the help of a Malaysian English teacher (at that time she was studying a Master’s Degree in English at Warwick University) and then was piloted in September 1998. After the analysis, the questionnaire was modified and distributed in January 1999. The probability sample schools were 20% of those in each of the seven selected states. The samples are summarised in Table 3.4.

<i>State</i>	<i>Total No. of National Schools (NS)</i>	<i>20% of Total No. of NS.</i>
Melaka	130	26
Selangor	300	60
Kedah	350	70
Kelantan	365	73
Perak	485	97
Negeri Sembilan	185	37
Perlis	51	10
<b>TOTAL</b>	<b>1866</b>	<b>373</b>

Table 3.4 Number of schools selected to respond to questionnaire

Therefore the number of questionnaires expected to be collected (2 respondents per school) was 746. The return rate was 77.5%.

### 3.5.2 Gaining access

Before I could undertake the fieldwork a tremendous amount of paperwork was required. Certain procedures have to be followed in conducting research in Malaysian Schools. Malaysia has a bureaucratic set up requiring anyone who wants to enter school premises to adhere to certain procedures. The first is to seek permission from the highest authority, the Ministry’s Educational Planning and Research Division (EPRD). The correspondence with EPRD was undertaken in July 1998 so that the State Education Departments could be given sufficient notification of the intended study. Permission came in early August, so I was able to use it



immediately to obtain clearance from the Penang State Education Department to undertake a pilot questionnaire and some fieldwork.

Permission to conduct fieldwork in the schools was facilitated by the fact that the researcher was sponsored by the Malaysian Education Ministry. Attached to the questionnaires sent to all the states involved in the main study were copies of permission letters from the EPRD and their own State Education Department. This was to ensure some obligation to respond to the questionnaire and generate a high return rate. The official correspondence was completed by October 1998 in readiness for the questionnaire distribution in January 1999.

The qualitative and the quantitative studies were done simultaneously due to time constraints and distance considerations, since postage costs for questionnaires between England and Malaysia are prohibitive. Thus, the analysis of the data was mainly done after the fieldwork. There was also a specific deadline to finish the study. Another reason was the high cost of travel (due to the Far Eastern economic crisis). However, a high percentage return rate was achieved.

#### *3.5.2.1 The fieldwork*

Before I was able to meet the teachers chosen for the study, I had to obtain permission from their schools. Thus letters were sent to the Headteachers of the nine schools in October 1998 explaining the aims of the study. The Headteachers were contacted again by telephone in December 1998, as a courtesy, to remind them I would be going to their schools in January. After I had contacted the Headteachers I also contacted the selected teachers so that they would be aware of our meetings. At this stage, some of the teachers contacted were not very enthusiastic and sounded very nervous.

The fieldwork was carried out between January 1999 and April 1999. There were 14 informants from the nine schools because at some there were two science teachers. The number of teachers chosen was based on what was thought to be manageable within the time available. In approaching the individual teachers, I assured them that my intention was not to evaluate them nor to find faults. I explained that my purpose was to understand how they implemented the primary science curriculum in their classes. I emphasised that they were the ones with the necessary information to describe the science curriculum as taught in their classes. I also made it clear that their opinions and views would be used in the study but the source would not be disclosed. This assurance helped me gain their confidence.

### ***3.5.3 Instruments***

Qualitative data were collected through interviews and classroom observations. The audio tape recorder was used extensively to record interviews and the classroom observation. The interviews were semi-structured and five interview schedules were prepared (see Table 3.2). However, some of the schedules were modified during the fieldwork. This was done to aid teachers' understanding of the questions. The initial classroom observation checklist was also found to be inappropriate due to the criteria not being applicable in the Malaysian context. Therefore it was decided to keep a written account of events as they occurred. Data for the quantitative section were collected through the questionnaire (Appendix 1).

#### ***3.5.3.1 Questionnaire***

The questionnaire developed was based on those of previous researchers. One such questionnaire was that developed for the School Council Research Project in the UK



by Taylor *et al.* (1974). The purpose of this study was to examine, through data based on teachers' perceptions, the physical, ideological and personal constraints and influences affecting what is taught by the primary school in its classrooms. It was felt that some parts of Taylor's questionnaire were appropriate for the present study.

Another source was the research done by the UK School Curriculum and Assessment Authority 'Evaluation of the Implementation of Science in the National Curriculum at Key Stages 1, 2, and 3' (Russell, Qualter and McGuigan 1994). The National Curriculum Council set out the specification parameters for the evaluation, which included the coverage, progression and differentiation of the science National Curriculum. The Primary Teacher Questionnaire used in the Evaluation Study is relevant to the present study for evaluating teachers' perceptions of the implementation of KBSR primary science.

Another source was materials produced by the Malaysian Curriculum Development Centre. These were the teachers' guide to the primary science syllabus, the module packages for teachers of primary science, i.e. module 2 - Scientific Skills, module 3 - Thinking Skills and module 4 - Scientific Attitudes and Values.

In all, eight sections of the questionnaire were developed. Section 1 seeks information about the teachers themselves and their background in science. Section 2 has two parts. Part (i) deals with the objectives of the primary science curriculum as stated by the Curriculum Development Centre (CDC) in the teachers' guide to the primary science syllabus. In this section, teachers' views are sought on the importance of each stated objective. Teachers were asked to rank the nine stated objectives according to their own perspective. Part (ii) consists of four open-ended

questions to enable teachers to give their own comment on the objectives of the primary science curriculum.

Section 3 explores teachers' perceptions of the constructivist approach. The items are adapted from Yager's (1991) article on 'The Constructivist Learning Model: Towards Real Reform in Science Education'. This article discusses constructivist strategies for teaching and suggests procedures for science teachers to develop constructivist approaches. Eleven items have been adapted which focus on pupils' roles in a constructivist approach. Further open-ended questions are provided to elicit teachers' perceptions on the approach to primary science. Some are adapted from Russell *et al.* (1994) and focussed on pupils' roles in a constructivist approach. One further item is focused on the teachers' roles in science lessons using a constructivist approach. Three open-ended questions about teachers' views on the constructivist approach relate to pupils' role and teachers' role. One open-ended item is modified from Russell *et al.* (1995) and asks for teachers' views, on a science lesson that they have taught recently and which they regarded as successful.

Section 4 seeks data on the science resources in the teachers' schools and how these resources help in teaching science. Six items were adapted and modified from Russell, *et al.* (1994) from the Primary Teacher Questionnaire regarding 'Science in Your School'. Three out of six items are open-ended questions developed by the researcher and relating to the use of the science room in the school during science lessons.

Section 5 aims to find out how teachers organise their pupils in science lessons. Six items are adapted from Russell *et al.*'s (1994) evaluation study, and two out of six items are open-ended questions. Four out of six items are adapted from Russell *et*



*al.*'s (1994) questionnaire on 'Organising Pupils'. These items were chosen because of their suitability for primary science in Malaysia, which also emphasises a pupil-centred approach that allows pupils to be involved in hands-on activities. Thus it is important to understand how teachers organise pupils in their science class.

Section 6 of the questionnaire was developed to explore teachers' views of their pupils' characteristics in science classes. Here, development by the researcher was guided by the materials produced by the CDC. Part 1 consists of 12 items based on the four modules written by the CDC:

- module 1 - Knowing Science
- module 2 - Scientific Skills
- module 3 - Thinking Skills
- module 4 - Scientific Attitudes and Values

Two items were developed to relate to the scientific skills pupils should acquire in science; one on pupils' scientific values and on their scientific attitudes. A further two items are on scientific concepts, two on thinking skills, and two on manipulative skills. Part 2 of the questionnaire asks for teachers' opinions on the three most important skills which should be given priority in primary science.

Section 7 attempts to discover teachers' perceptions of the barriers the implementation of the primary science curriculum. The items developed are adapted from the study by Taylor *et al.* (1974) on 'Purpose, Power and Constraint in the Primary School Curriculum'. Fifteen items used from their study are considered suitable for the teachers within the present study. The items used are adapted from two parts of Taylor *et al.*'s questionnaire. They are from section 3, which deals with the influence of certain people and organisations on what and how topics are taught in their classrooms. Only four items are adapted from this part, i.e. items i, iii, xi, and xii. Item ii was developed for this research. The other ten items are from section

4 of the study, which asked teachers to indicate the factors that prevented them from achieving their aims in teaching.

Lastly, section 8 deals with teachers' ideology, including their beliefs, attitudes and values towards the primary science curriculum. These questions are adapted from Russell *et al.* (1994). Twelve items from their study were modified to apply to KBSR science. Of the twelve items, three asked about teachers' beliefs, two about teachers' values and seven items about their attitudes. However, all items are implicitly related to teachers' ideology as a whole.

The questions developed in sections 3, 6, 7 and 8 use the 5-point Likert scale to reflect the intensity of the particular judgement involved (Nachmias and Nachmias 1996). In the questionnaire, the numerical codes accompanying the categories represent the intensity of the categories. The higher the number, the more positive the response. (For example 5 relates to strongly agree and 1 to strongly disagree). It was felt that using a 5-point Likert scale would allow the respondents to indicate realistically the strength of their attitudes towards teaching strategies and pupils' characteristics in science lessons.

A number of open-ended questions were developed for this questionnaire. They are in sections 1, 2, 3, 4 and 5. The researcher felt that by making use of open-ended questions she would be able to allow the respondents to reflect critically without being influenced by suggestions from the researcher. As the purpose of this study is to determine teachers' perceptions and thinking on the implementation of the primary science curriculum, some open-ended questions seemed appropriate in order to determine teachers' views and opinions.



After the questionnaire was piloted, the responses received were inspected to see whether any modification was necessary. The questions were retained but most of the open-ended items were modified into Likert-scale types. Only one open-ended question was retained. Teachers' responses indicated they did not like the open-ended questions as they were time consuming, and they found it difficult to set out their ideas.

#### **3.5.3.2 Observation schedules**

The observation schedule used in this study is adapted from Smith and Neale (1989) in their study of 'The Construction of Subject Matter Knowledge in Primary Science Teaching'. The purpose of their study was to analyse the subject matter knowledge and beliefs of ten primary teachers, focusing on their conceptual change in science. According to Smith and Neale (1989) the key features of conceptual change teaching are:

##### **(Lesson Segments)**

1. *Introduction*: teacher opens lesson with comments about lesson's content or activities, making links with other lessons
2. *Review*: teacher asks children to describe previous lessons' findings, conclusions and problems
3. *Lesson development*: teacher presents new information or problem, elicits children's ideas and discussion, probes and clarifies understanding
4. *Investigations/activities*: children manipulate materials individually, in small groups, or take turns in whole group, to test out ideas
5. *Representation*: children present results of activities symbolically, in writing, measurement, graphs, tracing
6. *Discussion of activities*: children present results, discuss explanations, comment on adequacy of explanations
7. *Summary or tie up*: teacher and/or children summarise the day's findings and link them to other lessons

Thus it can be seen that the development of the lesson is similar to a constructivist approach, with the lesson being focused on pupils' ideas and prior knowledge. The approach attaches importance to pupils' understanding of the concepts taught

through activity-based teaching thereby allowing pupils to construct their learning. Hence it was felt that the observation schedule was appropriate and suitable for observing the teaching of KBSR science in Malaysia.

As the observation schedule developed by Smith and Neale (1989) focuses on teachers' content knowledge, teachers' roles, students' roles and activities and materials, it can easily be adapted to observe teachers' pedagogical content knowledge. This includes teachers' subject knowledge, knowledge of the learner, and pedagogical knowledge (for this study, this includes classroom organisation and science pedagogy). However, the part of Smith and Neale's observation schedule which was adapted for the study is that which concerns teachers' content knowledge and teachers' knowledge of learner characteristics in science classes, since the other criteria developed by Smith and Neale are not relevant to the Malaysian primary science teaching. Therefore, the classroom observation data were analysed from the narrative description of the classroom observation.

### **3.6 Data Analysis**

The questionnaire was analysed using the Statistical Package for the Social Sciences (SPSS) programme and most of the statistical procedures used the frequency count and cross-tab procedure. Since the questionnaire items are mostly on opinions and views of the curriculum the frequency count of responses was suitable.

The qualitative data arising from the interviews and classroom observation were analysed using qualitative analysis. The interviews and classroom observation were initially transcribed and then analysed by finding units of meaning and looking for patterns in the interviews. A coding system was developed from 'perspectives held by subjects' to code orientations toward ways of thinking that all or some subjects



share, which indicate orientations toward particular aspects rather than general situation. Often perspectives were captured in particular phrases that subjects used (Bogdan and Biklen 1992, p.168). The classroom observations were recorded as narrative descriptions and were analysed according to criteria including strategies used in the lessons, pupils' development in science, i.e. science process skills and scientific attitudes and teacher's content knowledge.

### **3.7 Methodological Issues: Limitations and Advantages**

The methodology used in this study is a combination of qualitative and quantitative techniques. In the quantitative method, i.e. the questionnaire, the chief limitation was cost. This resulted in only being able to select 20% of schools from seven out of 14 states in Malaysia. Another limitation was the time factor. I feel that a more effective questionnaire could have been developed following the fieldwork. The responses from the interviews could have been used to improve the questions.

However, the advantage in administering the questionnaires was that representative views of many teachers on the implementation of the curriculum were obtained on a nation-wide basis.

A major advantage of the qualitative method was being able to observe the curriculum implemented at classroom level by teachers. The interviews also enabled the researcher to determine teacher's perceptions, opinions and views. It can be seen from the interview responses that teachers were able to demonstrate their feelings and understanding of the curriculum to someone willing to listen to their problems and concerns when teaching science. Another advantage was the ability to observe teachers in a classroom setting and this approach really showed that the implementation of the curriculum is carried out by teachers' using their own

discretion and interpretation of the curriculum. However, for one researcher, the number of teachers that could be observed was limited.



## **Chapter 4     REPORT AND ANALYSIS OF QUANTITATIVE DATA**

### **4.1 Introduction**

This chapter will present the data collected quantitatively. An attempt is made to explain the findings, which are analysed under the following headings:

- factual data on the samples
- teachers' views and perceptions of the objective of primary science
- teachers' pedagogical knowledge
- teachers' opinions on learners' characteristics in science
- teachers' perceptions on barriers to implementing the primary science curriculum
- teachers' values, beliefs and attitudes towards the primary science curriculum
- teachers' opinions on the idea of 'pupils as active learners'

### **4.2 Factual Data on Samples**

The sample in the quantitative study consisted of 578 teachers working in seven of the states in Malaysia. Questionnaires were sent to 373 schools, two questionnaires for each. The total number of questionnaires sent out was 746, generating a return of 578 (77.5%). Table 4.0 shows some factual data on the sample. Of 578 returns 41.5% are from male teachers and 58.7% are from females. The majority of teachers in primary schools are in the age group 20-35. The qualification that the majority (52.8%) holds is the Malaysian Certificate of Education, after form five of secondary education.

Since most teachers are aged between 20-35, it is not surprising that their teaching profile is as indicated. Their science teaching experience is spread, with some 40%

teaching the subject for four years or more, i.e. since the implementation of the curriculum. Only about a third (31.8%) took the science option during their teacher-training course/programme. However 64.2% of the respondents had attended an in-service course on primary science, and of these 291 (78.4%) teachers had taken a non-science option and 80 (21.6%) the science option (Table 4.1a).

Items	Responses	N	%
1 (sex)	Male	240	41.5
	Female	338	58.5
2 (age)	20-25	117	20.2
	26-30	145	25.1
	31-35	174	30.1
	36-40	84	14.5
	41-45	45	7.8
	>46	13	2.2
3 (qualification)	LCE (Lower Certificate of Education)	2	0.3
	MCE (Malaysian Certificate of Education)	305	52.8
	HSC (Higher School Certificate)	242	41.9
	DIPLOMA	29	5.0
4 (teaching experience)	<1 Year	17	2.9
	1-5 Years	242	41.9
	6-10 Years	125	21.6
	11-20 Years	168	29.1
	>20 Years	26	4.5
5 (science teaching experience)	<1 Year	46	8.0
	1 Year	76	13.1
	2 Years	119	20.6
	3 Years	106	18.3
	4 Years	103	17.8
	> 4 Years	128	22.1
6 (option during teacher training)	Science	184	31.8
	Non-science	394	68.2
9 (in-service course attended)	Yes	371	64.2
	No	207	35.8

Table 4.0 Teachers’ profiles and science backgrounds

The 207 teachers who have not attended in-service course are almost equally divided between science and non-science option takers: 104 (50.2%) and 103 (49.8%) respectively (Table 4.1).

			Science Option	Non-Science Option	Total
In-Service Attended	Yes	Count % Within In-Service Attended	80 21.6%	291 78.4%	371 100%
	No	Count % Within In-Service Attended	104 50.2%	103 49.8%	207 100%
Total		Count % Within In-Service Attended	184 31.8 %	394 68.2 %	578 100%

Table 4.1 A cross-tabulation of teachers attending in-service courses in primary science with the option taken during teacher training



Hence most teachers teaching science in primary schools are teachers with a non-science background. Those having taken the science option are newly qualified teachers, since the science option has only been available to those qualifying since 1997, two and a half years after the new curriculum's implementation.

N	Items	% Responses	
		Yes	No
574	7(a) art	40.1	59.9
574	7(b) Malay language	31.7	68.3
573	7(c) English language	7.0	93.0
574	7(d) Islamic religion studies	0.9	99.1
574	7(e) living skills	13.2	86.8
574	7(f) local studies	24.4	75.6
574	7(g) maths	36.4	63.6
574	7(h) moral education	4.0	96.0
574	7(i) music	14.5	85.5
574	7(j)physical education	39.0	61.0

Table 4.2 Other subjects taught by the respondents

Table 4.2 shows that the majority of teachers also teach art (39.8%), Malay language (31.5%), maths (36.2%), and physical education (38.3%). Primary school teachers in Malaysia are considered generalists, a situation similar to that in England and Wales when the National Curriculum was implemented (Bennett and Bisset 1993).

Year group	Responses	N	%
Year 4	Yes	273	47.2
	No	305	52.8
Year 5	Yes	329	56.9
	No	249	43.1
Year 6	Yes	367	63.5
	No	211	36.5

Table 4.3 The distribution of the respondents' science teaching in Years 4, 5 and 6

A majority of the respondents teach Year 6. In the primary school, Year 6 is considered the most crucial year for pupils as well as for teachers, since it is the final year before children enter secondary school. It is also crucial because there is a

national exam for pupils and the results are used for selection to good boarding schools and other prestigious secondary schools. As such, Year 6 teachers concentrate on achieving good results, since this is also a benchmark of the teachers' performance. Science is one of the key subjects in the Year 6 examination.

### 4.3 Teachers’ Views and Perceptions of Primary Science Objectives

(Section 2 - Item 10,11 and 12)

The primary science objectives as stated in the syllabus are to give pupils the opportunity to:

- (i) develop thinking skills to increase intellectual capability;
- (ii) increase interest in the environment;
- (iii) develop scientific skills in an inquiring manner;
- (iv) appreciate the orderliness of the universe;
- (v) gain knowledge and understanding of scientific concepts and facts in order to understand themselves and their environment;
- (vi) develop the ability to solve problems and make responsible decisions;
- (vii) increase their ability to cope with the latest contribution and innovations in science and technology;
- (viii) practice good moral values and scientific attitudes in everyday life;
- (ix) appreciate the contributions of science and technology for the welfare of man.

Item 10, N=578

	no importance	not very important	not sure	very important	extremely important
	%	%	%	%	%
pso-(i) thinking skill	.3%	.3%	2.4%	35.5%	61.4%
pso (ii)-interest	.3%	1.7%	3.6%	46.4%	47.9%
pso (iii)-science process	.3%	2.2%	9.3%	51.2%	36.9%
pso(iv)-universe	1.4%	3.3%	12.3%	53.3%	29.8%
pso (v)- science concepts	.5%	1.2%	3.3%	41.7%	53.3%
pso (vi)- problem solving ability	.3%	2.1%	10.9%	47.6%	39.1%
pso (vii)contribution in s&t	.2%	6.1%	23.2%	47.4%	23.2%
pso(viii)-sc att.&values	.3%	1.4%	8.3%	45.3%	44.6%
pso(ix)- app sc&tech	.9%	4.2%	5.7%	45.1%	44.1%

Table 4.4 Teachers opinion on the importance of primary science objectives (pso)



Table 4.4 shows that most teachers agree that all nine objectives are either very important or extremely important. The three objectives, that most teachers feel to be extremely important are:

- objective i – 61.4%
- objective v – 53.3%
- objective ii – 47.9%

When asked to rank the objectives in order of importance, teachers judged objective (i) to be by far the most important. The following data were obtained (Table 4.5):

Item 11, N=574

Objectives	Most important (%)	2 <sup>nd</sup> Most important (%)	Combination of 1 <sup>st</sup> and 2 <sup>nd</sup> preferences (%)
(i)	66.0	8.9	74.9
(ii)	10.6	7.1	17.7
(iii)	9.9	28.0	37.9
(iv)	1.2	1.2	2.4
(v)	9.8	36.7	45.5
(vi)	0.7	9.8	10.2
(vii)	0	1.1	1.1
(viii)	0.9	5.0	5.9
(ix)	0.9	2.3	3.2

Table 4.5 Teachers’ ranking of the importance of the objectives of primary science

Taking the first and second preferences together indicates that objective (v) is seen to be the second most important, followed by objective (iii). Objectives (ii) and (vi) are somewhat less important to the teachers, with the remaining objectives (iv, vii, viii, ix) being seen as much less important.

Table 4.6, shows that for most objectives ii (71.3%), viii (61.0%) and ix (59.0%) were easy to understand and implement, whereas objectives i (57.9%), iii (67.3%), v (48.0%), vi (56.3%), and vii (51.2%) can be understood but were difficult to implement.

Item 12

	understand and easy to implement	understand but difficult to implement	understand but do not know how to implement	do not understand
	%	%	%	%
obj(i), N=575	34.1%	57.9%	6.6%	1.4%
obj(ii), N=575	71.3%	22.6%	4.9%	1.2%
obj (iii), N=575	20.5%	67.3%	10.6%	1.6%
obj (iv), N=572	39.3%	34.4%	15.9%	10.3%
obj (v), N=573	35.3%	48.0%	12.9%	3.8%
obj (vi), N=575	32.3%	56.3%	9.2%	2.1%
obj (vii), N= 578	16.3%	51.2%	24.1%	8.3%
obj (viii), N= 575	61.0%	32.7%	5.2%	1.0%
obj (ix), N=574	59.0%	28.2%	10.4%	2.4%

Table 4.6 Teachers views on their understanding on the primary science objectives (obj) and the degree of the difficulty of implementation

**4.3.1 The interpretation of teachers’ views and perceptions of primary science objectives**

Tables 4.4, 4.5 and 4.6 show teachers’ views and perceptions of the primary science curriculum objectives as mandated in the curriculum guide. When teachers receive instructions or directives from central government, they believe they must be followed and carried out promptly. This assumption is reflected in the questionnaire responses. When teachers were asked to state the importance they attach to the objectives, all replied either “important” or “extremely important”, even though the questionnaires specifically asked them to answer in the context of their pupils’ and their schools’ backgrounds. The implication is that teachers’ responses were conditioned by the need to be seen to conform to the official directives, in spite of the fact that anonymity was assured. Therefore, these responses might not accurately reflect teachers’ individual practice in the implementation of the objectives. However, when they were asked to rank the objectives, it can be seen that not all the objectives were given the same degree of importance. In fact, there is a distinct



group of objectives which, were perceived to be of much less importance by the teachers. As explained earlier, the Malaysian education system has a plethora of instructions and directives and teachers subscribe to the ideology that they must abide by these directives and they rarely use their discretion in evaluating their own practice. Thus, all objectives are marked either “important” or “extremely important” despite teachers’ own circumstances or their pupils’ varying abilities. Despite the above, most teachers attach importance to the development of thinking skills and to giving pupils the opportunity to gain knowledge and understanding of science concepts and facts. This is supported by information in Chart 1(section 4.42), which shows that the role teachers most frequently use in their science lessons is that of ‘information-giver’. This is despite the fact that the planners suggested that the curriculum should be taught using a guided inquiry and constructivist approach. Teachers claimed that the development of thinking skills was the most important objective, but this conflicts with the finding that they act as information givers. Since these two objectives are not mutually exclusive, this may be a consequence of a lack of training in science pedagogy. If teachers understand both the science curriculum and the developers’ ideas on its delivery, a mismatch between their role and the preferred teaching strategy is not inevitable. However, at present teachers’ roles do not match the suggestions of the curriculum developers; the suggested approach to primary science cannot be applied if teachers are mainly information givers in the traditional sense. The suggestion is not that this role should be abandoned, but if it becomes teachers’ normal practice in science lessons, the suggested guided inquiry will diminish over time. One of the factors that relate to this issue can be seen from teachers’ responses on the understanding of the primary science objectives and the

question on the degree of implementation (Questions 11 and 12). Teachers understand most of the objectives, but they have some difficulty in implementing, especially the following objectives:

- (i) develop thinking skills to increase intellectual capability;
- (iii) develop scientific skills, attitudes and an inquiring manner;
- (v) gain knowledge and understanding of scientific concepts and facts in order to understand themselves and their environment;
- (vi) develop the ability to solve problems and make responsible decisions;
- (vii) increase their ability to cope with the latest contribution and innovations in science and technology.

Thus, teachers find it difficult to implement five out of the nine objectives. This is in contradiction to teachers' ranking of the objectives and the role they most frequently play in their classrooms. Looking at the objectives, it is clear that, in order to be able to implement them, teachers need effective science pedagogical knowledge.

Another factor of significance in this respect is the teachers' perceptions of pupils as 'active learners'. The reasons why some teachers claimed that it was not possible to apply these ideas in their classrooms are explained in section 4.8. However, there can be little doubt that it is the teachers' understanding of how to implement those objectives that needs to be addressed. It is their science pedagogical knowledge that needs upgrading and supporting (see, for example, Neale *et al.* 1990, Summers 1994). Understanding a statement and implementing it need careful deliberation and in-depth discussion. Thus, in-service courses which develop teachers' science pedagogy need to be provided. Summers (1994) argues that 'an analysis of the content knowledge required by teachers is not enough but it is also necessary to identify appropriate pedagogical content knowledge in relation to the particular ideas and concepts to be taught'. Teachers need more than a mere introduction and



explanation of the strategy or methods to be used; they need focused support towards a classroom implementation of the strategies. By having demonstration and discussion, teachers would be more able to implement the objectives.

It is unfortunate that the objectives that most respondents find difficult to implement are those which are important if pupils are to gain from the science curriculum. The objectives which teachers are able to understand and implement easily are those which are in the affective domain. They are: (ii) 'increase interest in the environment', (viii) 'practice good moral values and scientific attitudes in everyday life' and (ix) 'appreciate the contribution of science and technology for the welfare of mankind'. The teachers' replies, for these objectives, are possibly related to the fact that they are not included in the examinations or assessed during the course. Therefore, they might be implemented indirectly during the lesson. Ironically, for objective (iv), 'appreciate the orderliness in the universe', a high percentage of teachers stated that they understood the objective but found it difficult to implement. Another objective which does not belong to the cognitive domain is objective (vii), 'increase their ability to cope with the latest contributions and innovations in science and technology'. This also was found to be understood but difficult to implement. It might be argued that both of these statements are vague, and that teachers were reluctant to admit that they did not understand them, but instead claimed that they were difficult to implement.

One implication is that the objectives need to be made clearer and more precise so that the teachers are able to implement the curriculum as intended. The objectives for primary science should be revised and categorised in terms of the nature of the subject, the methods of scientific inquiry, and the knowledge and understanding

pupils should gain - the core importance of the objectives. Motivation, personal and moral development, scientific attitudes and value judgements should be complementary objectives. Furthermore, these objectives should be written in a way that shows the relationships between categories, and this should enhance the teachers' understanding. The way in which the curriculum is set out does not show the implicit meaning of the statements (Appendix 11). Teachers are required to read between the lines to understand the meaning, and sometimes their interpretation will not accurately reflect the developers' intent.

At present the complementary objectives are seen as unimportant. Teachers should give prior consideration towards developing these objectives, which determine how science can contribute to the pupils' personal and moral values, and they should not assume that the complementary objectives are something that can be 'caught' and not 'taught'. For example, for personal and moral development, if teachers could guide pupils through dialogues in evaluating evidence, making decisions and solving problems, this would help pupils to achieve this objective. If all teachers could practise this, the complementary objectives would be achieved by the end of primary schooling.

In summary, it is important for Malaysian primary science teachers, either through in-service or in initial training, to develop an in-depth understanding of the objectives before they are able to teach the subject. As already explained, it is common practice in Malaysia when a new curriculum innovation is proposed, for short orientation courses to be held to disseminate the new curriculum. The objectives will be summarised briefly in a lecture session. This approach needs modification, since the evidence shows that teachers find it difficult to implement



the objectives due to a lack of understanding. In in-service courses, teachers should discuss and debate the objectives continually because new teachers without science training are recruited each year. Furthermore, there needs to be an academic discussion to develop new perspectives. As the present researcher has experienced and also observed, most Malaysian teachers believe in 'restricted professionalism' (Hoyle 1980). This means that teaching is confined to the classroom, between the teacher and the pupils. Rarely do teachers discuss their teaching with colleagues. Pair teaching is only experienced during training. Once teachers graduate, they immediately conform to this 'restricted professionalism'. Pedagogy should be discussed and debated amongst science educators to obtain a global view of what primary science education should be and what pathways are needed to ensure that the pupils achieve the science objectives. Once the objectives are fully understood by the teachers, they will be internalised and become part of their tacit craft knowledge. Cronin-Jones (1991) states that, when new intended curricula are developed, teachers should receive some in-depth exposure to the rationale and theoretical perspectives underlying the curriculum choice of objectives, content and instructional strategies. If teachers understand why a curriculum addresses certain objectives or recommends particular instructional strategies, they will be more than willing to try to use the curriculum as intended. Appleton *et al.* (cited in Biddulph and Carr, 1991) found that teachers were unable to construct intended meaning from written materials, even though they thought they had done so, and therefore they were unable to implement the approach as envisaged by the authors. Their approach was influenced by their prior ideas of science, their role as teachers, and their assumptions about how children learn. Biddulph (cited in Biddulph and Carr, 1991)

found that only a minority of teachers could interpret the written materials and implement the interactive teaching approach as intended. He further stated that most teachers would require a special in-service course to support them in a change of perspective and practice.

This is consistent with the data in this study, which reveal the difficulties teachers experience in implementing the curriculum. The reason seems to be that the time given for them to assimilate the new curriculum is too short, and short in-service courses do not help. Thus, reading the material from the CDC would not help them to construct the intended meaning. This issue must be taken into consideration by curriculum developers, and a continuous in-service follow-up programme should be prepared for teachers in order to support their instructional and other needs in science education.

#### **4.4 Teachers' Science Pedagogical Knowledge**

In this section, teachers' science pedagogical knowledge are analysed and their views on the constructivist approach, the roles teachers play in science classes, their general pedagogical knowledge, pupils' organisation in science classes, and the tasks given to pupils.

##### ***4.4.1 Teachers' views on teaching strategies (the constructivist approach) in science lessons***

Item 13 in Section 3 of the questionnaire used 12 criteria to determine teachers' responses to the constructivist approach. They are:

- (i) I always use open-ended questions to encourage my pupils to elaborate their responses;
- (ii) It is difficult for me to encourage questions and ideas from my pupils to direct lessons;
- (iii) It is difficult to promote pupils' leadership qualities as a result of the learning process;
- (iv) I encourage my pupils to use alternative sources of information both from written materials and experts;



- (v) I encourage my pupils to test their own ideas, i.e. by answering their questions, their guesses as to cause, and their predictions of certain consequences;
- (vi) I think it is not necessary to encourage my pupils to challenge each other's conceptualisation and ideas;
- (vii) I always make sure that my pupils have adequate time for reflection and analysis after each science lesson;
- (viii) I find it difficult to use all the ideas my pupils generate during a teaching session;
- (ix) I respect all ideas my pupils generate;
- (x) I find it difficult to encourage my pupils to collect real evidence to support their ideas;
- (xi) I am not able to determine if my pupils are able to reformulate their previous ideas;
- (xii) I often use co-operative learning strategies that emphasise collaboration, respect, tolerance, individuality, and the use of division of labour tactics.

The following data were obtained (Table 4.7):

Item 13

	strongly disagree	disagree	not sure	agree	strongly agree
	%	%	%	%	%
ca(i), N=578	.9%	2.6%	2.8%	47.9%	45.8%
ca(ii), N=578	3.1%	26.5%	14.7%	46.4%	9.3%
ca(iii), N=578	2.6%	30.3%	11.8%	46.0%	9.3%
ca(iv), N=578	.7%	5.0%	12.6%	59.7%	22.0%
ca(v), N=578	.5%	8.0%	11.6%	56.4%	23.5%
ca(vi), N=578	15.7%	52.6%	21.1%	9.0%	1.6%
ca(vii), N=577	.3%	6.2%	27.0%	54.7%	11.8%
ca(viii), N=577	5.4%	41.4%	23.1%	26.5%	3.6%
ca(ix), N=577	.3%	2.2%	4.2%	59.2%	34.1%
ca(x), N=578	4.8%	29.8%	15.2%	43.9%	6.2%
ca(xi), N=576	3.0%	31.4%	37.2%	24.5%	4.0%
ca(xii), N=573	1.2%	4.0%	7.5%	52.5%	34.7%

Table 4.7 Teachers' views on the constructivist approach (ca – children's attribute)

47.9% of respondents claim to use open-ended questions to encourage pupils to elaborate their responses and a further 45.8% agreed strongly. However, 46.4% claim that it is difficult for them to encourage questions and elicit ideas from their pupils.

It is difficult for many teachers (46.0%) to promote leadership qualities in the learning process. 59.7% teachers state that they encourage pupils to use alternative sources of information but most teachers (43.9%) find it difficult to encourage their pupils to collect real evidence to support their ideas. 56.4% of teachers encourage

pupils to test their own ideas. Many teachers (52.6%) disagree that it is unnecessary for pupils to challenge each other's ideas. 41.3 % teachers disagree that they have difficulty in using all ideas pupils generate, and a majority (59.2%) of teachers respect all ideas generated by pupils. 54.7% of teachers think that pupils should have adequate time for reflection and analysis after each lesson. Furthermore 37.2% of teachers are not sure whether they can determine if their pupils have reformulated their previous ideas, but 34.4 % think they can and 28.5% that think they cannot. 87.2% of teachers agree or strongly agree that they often use co-operative learning strategies.

One of the approaches to primary science suggested by the curriculum developers is the constructivist approach. In fact, Module 12- 'Teaching and Learning Strategy (III)' has been developed by the Malaysian CDC to help teachers use this approach. However, the evidence from the data suggests that the effectiveness of this module must be doubted. From the data, it can be interpreted that most respondents, when asked about aspects of teaching strategy based on the constructivist model (see also Yager, 1991), agree with the criteria of the model. However, the responses to two criteria show that their views do not help them to move towards a constructivist approach. 46.4% of respondent state that it is difficult for them to encourage questions and ideas from their pupils in order to direct lessons. This conflicts with their views on encouraging pupils to test their own ideas (56.4% claim they offer such encouragement). In order to test their own ideas, pupils must first generate ideas, and if teachers cannot encourage this, the lesson becomes teacher-centred. This implies that the model is not being applied. Another piece of contradictory evidence is that teachers do not find it difficult to use all the ideas' pupils generate.



Thus, there should be no difficulty in eliciting pupils' ideas in order to direct the lesson. Answers to criterion (xi), 'I am not able to determine if my pupils are able to reformulate their previous ideas', also cast some doubt on whether respondents are actually using the constructivist approach. 28.4% of teachers agree and a further 37.0% are not sure. This is central to the constructivist learning model, and it is important for teachers to determine this to see whether meaningful learning has occurred. If pupils are able to reformulate their previous ideas, then they are correcting their alternative frameworks or misconceptions.

The argument that the teachers are not moving towards constructivism is strengthened by criterion (x), where 43.9% of respondents agree that they find it difficult to encourage their pupils to collect real evidence to support ideas. This is related to criterion (ii), where teachers find it difficult to encourage pupils' own ideas in order to direct the lesson. In the constructivist model, pupils are the main participants in the learning process. Thus, when teachers claim that they find it difficult to promote pupils' leadership qualities, there are two implications. First, pupils are too teacher-dependent and most learning will result from teacher direction or instruction. Secondly, teachers' beliefs that pupils are not able to carry out activities on their own show that teachers underestimate the potential of their children. Data for the remaining questions (criteria ii, vii, ix, xii) imply that science teaching is learner-centred, as encouraged in the curriculum guide. The evidence on using co-operative learning supports this. Asking questions and respecting pupils' ideas are considered to have been applied during the introduction to a lesson, when teachers explore pupils' prior knowledge. However, the ideas are not followed up or

used when teachers have already prepared worksheets and questions for pupils to answer. (This was seen in all the classroom observations).

This evidence strongly indicates the help that teachers need in instructional techniques if, as the Ministry of Education hopes, the constructivist approach is to be implemented. If Malaysia hopes to become a centre of excellence in education, then the basic pedagogic needs of primary science teachers must be supported. As discussed earlier, written material alone cannot ensure that teachers implement the intended curriculum. There have been many articles and research reports on the constructivist approach in science teaching and Malaysian primary science teachers need to be given accurate insights into this approach, including classroom applications. Teachers could discover the approach in a meaningful way if they themselves went through the process during training.

#### 4.4.2 Teachers’ roles in science lessons

Table 4.8 shows the roles teachers play in science lessons.  
Item 14 (a), N=577

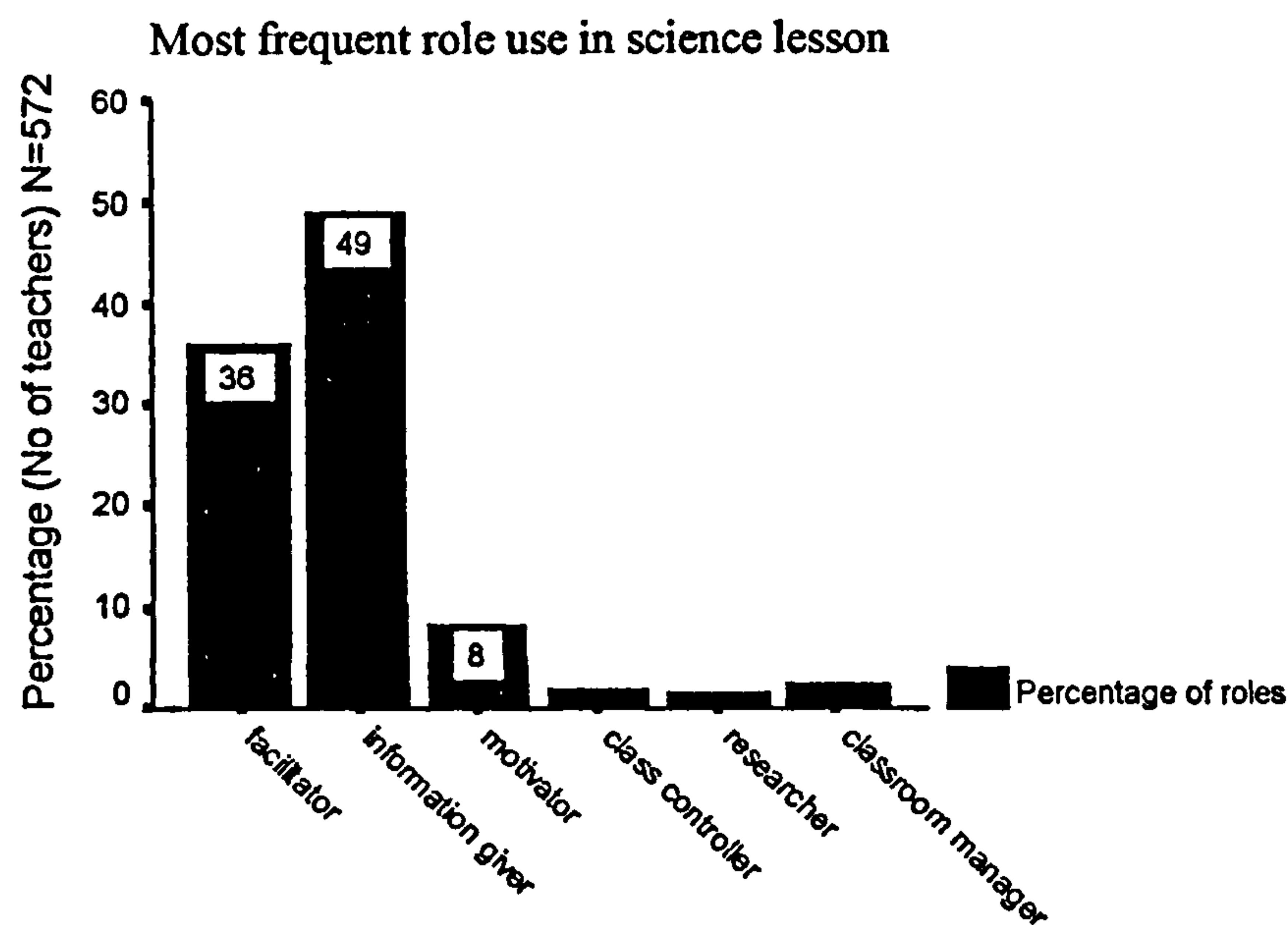
<b>Roles</b>	<b>Responses</b>	<b>%</b>
Facilitator	Yes	90.5
	No	9.5
Information giver	Yes	91.5
	No	8.5
Motivator	Yes	88.2
	No	11.8
Classroom controller	Yes	75.0
	No	25.0
Researcher	Yes	51.6
	No	48.4
Class manager	Yes	73.0
	No	27.0

Table 4.8 Roles teachers play in science classes

With the possible exception of ‘researcher’, teachers consider all the roles to be very important, with those of facilitator, information giver and motivator being



predominant. When teachers are asked to choose which role they play most often in science, their responses are as in Chart 1.



roles teachers play

Chart 1 The roles teachers play in science class

That most respondents play the role of information giver conflicts with the role teachers should play in the constructivict learning model. According to Driver and Oldham (1986):

*‘Unlike the dominant conception of a teacher’s role, s/he is viewed not as a transmitter of knowledge but as someone who facilitates conceptual change by encouraging pupils to engage actively in the personal construction of meaning; in order to do this there need to be frequent opportunities for pupils to make their ideas explicit and to communicate them.’ (p. 116)*

The importance of the role of facilitator is also emphasised by Scott, Dyson and Gater (1987), who state:

*‘From the constructivist perspective, the role of the teacher is modified. No longer does the teacher play the part of “purveyor of knowledge”. The teacher’s role becomes one of diagnostician, prescriber of appropriate learning activities and facilitator of learning.’ (p.16)*

This also supported by Sutherland and Boyes (1993), who point out that:

*‘The constructivist approach requires that the teachers be other than that of a bestower of knowledge. It means that the teacher must shift attention more frequently from the whole class to the individual pupils, resulting in greater awareness by the teacher of individual needs and differences.’ (p.74)*

These views on constructivist learning imply that teachers' roles must be modified so that they are no longer predominantly transmitters of knowledge. Thus, when most Malaysian teachers claimed that they are information givers, there is evidence that they are not moving towards this learning model (question 13). The second most frequent role is that of facilitator. Teachers assume that this role only involves providing suitable experiences from which children can learn, and setting up a structured activity for them to be involved in during learning. However, being a facilitator should involve more than this. It should comprise the roles of enabler, manager, presenter, adviser, observer, challenger, respondent and evaluator (Sutherland and Boyes 1993). Thus Malaysian primary science teachers must redefine the meaning of the role of facilitator if they aspire to move towards a constructivist learning model. Claiming that they are using the facilitator role is not enough to imply a constructivist approach. It is misleading to equate the constructivist approach with the role of facilitator. This goes some way to explain the apparent contradictions in the questionnaire data.

#### ***4.4.3 Teachers' opinions on general pedagogical knowledge***

59.3% of teachers are of the opinion that their schools have sufficient science reference books, but 40.7% claim otherwise. On the other hand, 62.5% of teachers maintain that they do not have enough science equipment and materials, with only 37.5% claiming they have enough. These figures indicate that many, if not most, of Malaysian schools still lack sufficient books, equipment and materials. An ideal, in order for pupils to handle equipment and materials, would be enough for each pair of pupils. Having only one set of equipment for 6-8 pupils in a group defeats the



purpose of practical science activity - only one or two pupils would actually be engaged in the activity. This was often seen during the classroom observations.

Primary schools need support for science education not only from the Education Ministry but also from the wider community, parents and industrial concerns.

Schools should develop a close relationship with these sectors for resource provision and for pedagogical reasons. In the UK, for example, a large number of organisations support science education. Dengate (1999) divides these organisations into five categories:

- professional bodies and association whose aim is to support teachers [for example: Geological Society, Geologists Association, Institute of Biology (IOB)];
- learned societies whose aim is to support scientists [for example: Royal Society, Royal Society of Edinburgh (RSE), Institute of Physics];
- commercial, industrial and governmental organisations whose scientific activities generate material relevant to science education, some of whom seek to influence what is taught to meet their aims [for example: Council for Science and Technology (CTS), Office of Science and Technology, Engineering and Physical Sciences Research Council (EPSRC)];
- special interest groups and charitable bodies who seek to promote their aims through influencing what pupils are taught [for example: Association for Science Education – ASE, Earth Science Teachers’ Association – ESTA, BAYS Science Club – British Association for the Advancement of Science: Youth Section];
- commercially based organisations that sell services to science educators [for example: BP Educational Service (BPES), BT Education Service, Shell Education Service]

As Malaysia is still a developing country, support from the Ministry of Education is very limited for many primary schools, and as the system of education is centralised, support comes from only one source, resulting in limited resources for any one school. Since science is considered a core subject for all pupils, extra resources are essential. In the UK, for example, education is also the responsibility of the Teacher Training Agency (TTA); the Qualification and Curriculum Authority (QCA); and the Department for Education and Employment (DfEE) as major funding bodies.

Another effective national agency is the Manpower Services Commission (MSC), which gave funds to schools via a branch of the Department of Trade and Industry (Blenkin, Edward and Kelly 1992).

4.4.3.1 Teachers use of science rooms in their schools

According to our research findings, a small majority of teachers (56.2%) use the science room often, 37.5% use it for part of their teaching and 6.1% do not teach science in a special room. The majority of teachers agree or strongly agree that these are good reasons for teaching in specialised room (Table 4.9).

N	Items	Responses	%	A + SA
554	19(a) easy access to science equipment and material	Strongly disagree (SD) Disagree (D) Not sure (NS) Agree (A) Strongly agree (SA)	1.7 7.6 6.6 44.3 35.6	79.9
555	19(d) easy control of pupils during activities	Strongly disagree (SD) Disagree (D) Not sure (NS) Agree (A) Strongly agree (SA)	1.7 7.1 5.9 55.4 26.0	81.4
555	19(e) availability of teaching aids	Strongly disagree (SD) Disagree (D) Not sure (NS) Agree (A) Strongly agree (SA)	1.6 8.1 7.3 50.0 29.1	79.1
554	19(b) arrangement of chairs and desks	Strongly disagree (SD) Disagree (D) Not sure (NS) Agree (A) Strongly agree (SA)	1.7 7.6 5.0 45.5 36.0	81.5

Table 4.9 Teachers reasons for using the science room

Teachers’ responses to possible reasons for not using a specialised room, either for some lessons or never were as in Table 4.10.

N	Items	Responses	%	A+SA
568	20(a) no science room available	Strongly disagree (SD) Disagree (D) Not sure (NS) Agree (A) Strongly agree (SA)	57.2 30.5 1.2 4.9 6.2	11.1
568	20(b) it is used as store room	Strongly disagree (SD) Disagree (D) Not sure (NS) Agree (A) Strongly agree (SA)	33.3 27.6 3.7 26.6 8.8	35.4
568	20(c) the science room is too small	Strongly disagree (SD) Disagree (D) Not sure (NS) Agree (A) Strongly agree (SA)	32.6 34.0 3.5 19.5 10.4	29.9
568	20(d) it is difficult to control pupils	Strongly disagree (SD) Disagree (D) Not sure (NS) Agree (A) Strongly agree (SA)	38.4 43.5 3.9 11.3 3.0	14.3

Table 4.10 Teachers reasons for not using the science room



This can be partly be explained by the fact that most schools have renovated classrooms for science use (except for newly built schools), and classroom observations confirmed that the modified classrooms were very crowded with an average of 38-45 pupils doing science. However, despite this, most teachers still feel happy using the science room. Most teachers will make do with whatever facilities are available.

*4.4.3.2 Teachers' organisation of pupils in science lessons*  
(Section 5 - Item 21, 22, 23, 24)

Item 21, N=576

Responses	%
(a) Always in small group, no whole class teaching	5.2
(b) Mostly in small group, some whole class teaching	35.6
(c) Mostly whole class teaching, some small group work	57.1
(d) Always as a whole class, no small group work	2.1

Table 4.11 Teachers organisation of pupils in science lessons

The majority of teachers (59.2%) always (2.1%), or most of the time (57.1%), undertake whole class teaching, while a sizeable minority (40.8%) organise group work, either always (5.2%) or for most of the time (35.6%) (Table 4.11).

The most frequent role of the teachers (Table 4.12) is that of ‘information giver’ (49.6%), and 57.2% of teachers assume this role through whole class teaching or group work. This implies that they find it easier to impart science content in this way.

According to our research findings, pupils are taught science in mixed ability groups. 45.0% of teachers group children by ability, and 61.6% of teachers group pupils in science lessons in this way. The benefit of mixed ability grouping for effective

learning in science is discussed by Howe (1990) in her studies of the composition of groups pupils aged 8-12 in the UK:

*‘Looking at the change from the pre-tests to those post-tests which were administered several weeks after the group task, it is clear that on five out of six comparisons the children from the differing groups progressed more than the children from the similar groups. Moreover, when the differing groups contained children whose level of understanding varied, the more advanced children progressed as much as the less. This being the case, we felt our results provide reasonably consistent evidence for the task being more effective with differing groups.’ (p.27)*

Howe (1990) showed that with groups of children of differing abilities, pupils could work together co-operatively. This is supported by the qualitative data of the present study.

			pupils' organisation in science lesson				Total
			always in small group, no whole class teaching	mostly in small groups, some whole class teaching	mostly as a whole class, some small group work	always as a whole class, no small group work	
most frequent role teachers play in science lesson	facilitator	Count	9	98	99	1	207
		% within classroom organisation	30.0%	48.8%	30.3%	8.3%	36.3%
	information giver	Count	14	72	187	10	283
		% within classroom organisation	46.7%	35.8%	57.2%	83.3%	49.6%
	motivator	Count	6	16	26		48
		% within classroom organisation	20.0%	8.0%	8.0%		8.4%
	class controller	Count		5	5		10
		% within classroom organisation		2.5%	1.5%		1.8%
	researcher	Count		6	1	1	8
		% within classroom organisation		3.0%	.3%	8.3%	1.4%
	classroom manager	Count	1	4	9		14
		% within classroom organisation	3.3%	2.0%	2.8%		2.5%
Total		Count	30	201	327	12	570
		% within classroom organisation	100.0%	100.0%	100.0%	100.0%	100.0%

Table 4.12 A cross-tabulation of teachers' roles and classroom organisation in science classes

The reason that most teachers gave during the interviews for having different abilities in a group was that the low-ability pupils would benefit from those of higher ability. Thus they would not be left behind, as they might be if put together in a low-



ability group. Perhaps teachers perceive that preparing the same task for the whole class is easier to plan and more appropriate for the pupils. This is in contrast to the situation in the UK, where differentiated work is seen to be essential (for example, DES 1985, Naylor and Keogh 1997, 1998a, 1998b Harrison, Simon and Watson 2000). Schilling (1993) argues that decisions about group composition are the teachers' responsibility, and it is important to consider whether to use friendship, ability, gender or social and cultural background as a criterion for asking children to work together. The implication is that teachers' should be flexible in their approach to group composition, taking account of the nature of the activity, the resources available and the needs and abilities of individual children.

**4.4.4 Tasks given by teachers to pupils in science lessons**

Our results show that 91.0% of teachers give all their pupils the same tasks to take forward as far as possible and 83.7% give all pupils the same science activities to carry out (Table 4.13).

Item 24(i)

N	Item	Responses %	
		Yes	No
577	24(a) All pupils are given the same activities	83.7	16.3
576	24(b) Pupils always generate their own activities	35.2	64.8
577	24(c)The starting points are the same, but pupils develop activities in an individual direction	67.6	32.4
577	24(d) Pupils are given modified tasks according to their ability	48.7	51.3
577	24(e) All pupils are given the same tasks and take them foward as far as possible	91.0	9.0

Table 4.13 Tasks given by teachers to pupils in science lessons

As Table 4.13a shows 45.5% of teachers state that, most frequently, the same tasks are given to pupils to take them forward as far as possible.

Item 24 (ii), N=574

Responses	%
(a) All pupils are given the same activities	27.7
(b) Pupils always generate their own activities	1.7
(c)The starting points are the same, but pupils develop activities in an individual direction	16.2
(d) Pupils are given modified activities according to their ability	8.9
(e) All pupils are given the same tasks and take them forward as far as possible	45.5

Table 4.13a Most frequent task given by teachers to pupils in science lessons

Table 4.14 shows a cross-tabulation of the most frequent role teachers play and the most frequent type of task they give to pupils.

			most frequent task given to pupils in science lesson (FT)					Total
			a	b	c	d	e	
most frequent role teachers play in science lesson	facilitator	Count	50	5	30	17	104	206
		% within FT	31.6%	50.0%	32.6%	34.0%	40.3%	36.3%
	information giver	Count	89	4	48	28	117	282
		% within FT	56.3%	40.0%	50.0%	52.0%	45.3%	49.6%
	motivator	Count	9	1	14	3	21	48
		% within FT	5.7%	10.0%	15.2%	6.0%	8.1%	8.5%
	class controller	Count	2		1	2	6	11
		% within FT	1.3%		1.1%	4.0%	2.3%	1.9%
	researcher	Count	3			2	2	7
		% within FT	1.9%			4.0%	.8%	1.2%
	classroom manager	Count	5		1		8	14
		% within FT	3.2%		1.1%		3.1%	2.5%
Total		Count	158	10	92	50	258	568
		% within FT	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 4.14 A cross-tabulation of teachers’ most frequent role and pupils’ frequent task

- a -All pupils are given the same activities
- b -Pupils always generate their own activities
- c -The starting points are the same, but pupils develop activities in an individual direction
- d -Pupils are given modified activities according to their abilities
- e -All pupils are given the same tasks and take them forward as far as possible

Most teachers (56.3%) adopt the role of information giver and give all pupils the same activities. This is in conflict with the role advocated by the constructivist approach. The data confirm teachers’ understanding of the principles underpinning



the curriculum. Teachers know that pupils should be given a range of tasks, but the traditional belief that pupils should be given a high science content is widely held. Hence, the high percentage of teachers in the ‘information giver’ role.

Giving the same activities to all pupils and ending with the same conclusion (as observed in classrooms) contradicts the claim that pupils will be taken to the limits of their abilities.

The majority of respondents organise pupils mainly for whole class teaching with some small group work (Table 4.11), implying that science teaching is less geared to individual needs. This suggests that teachers are not actually taking pupils to the limits of their abilities. This is supported by classroom observations: all the lessons observed began with teachers explaining what pupils should be doing in their common experiments. A further implication emerging from this data is that pupils are streamed according to their overall ability, and so pupils in each class are assumed to be of the same ability. Hence the activity prepared is the same for the whole class.

#### **4.5 Teachers’ Opinions about Learners’ Characteristics**

Item 25 in section 6 of the questionnaire used 12 criteria to determine teachers’ opinions about the following learners’ characteristics. The child should be able to:

- (i) develop critical and discriminating attitudes;
- (ii) understand all scientific concepts taught by teachers;
- (iii) handle scientific materials and specimens properly;
- (iv) memorise concepts taught in preparation for their national examination (UPSR);
- (v) use scientific drawing with great accuracy;
- (vi) talk about his own and others’ opinions/ideas in a reasonable way;
- (vii) develop creativity and inventiveness in some fields;
- (viii) convey his/her meaning clearly and accurately during discussions;
- (ix) know some simple and basic process skills such as observation, prediction, making inference, classifying and communication;
- (x) acquire knowledge and information from written materials, for example summarising, taking notes accurately, using the library and computer;

- (xi) show a set of scientific values on which to base his/her behaviour, for example honesty, sincerity and personal responsibility, tolerance, respect, appreciating others, their feelings, views and capabilities;
- (xii) plan independent work where s/he is capable of using the integrated science process skills such as making hypotheses, manipulating variables, analysing information, self-experimenting and organising his/her own time.

Table 4.15 shows teachers opinions on the importance of the various science skills for pupils.

Item 25

	the skill is very important	the skill is important	the skill is of relatively minor importance	the skill is unimportant
	%	%	%	%
pc1-critical & discriminating attitude	38.0	52.2	8.3	1.6
pc2-understand all science concepts	50.6	42.5	5.9	1.0
pc3-handle science materials & specimens properly	40.4	53.2	5.7	.7
pc4-memorise concepts	23.3	41.1	29.5	6.1
pc5-use scientific drawing accurately	12.0	52.9	30.7	4.5
pc6-talk about his and other's opinions reasonably	16.5	62.6	18.8	2.1
pc7-creative&inventive	18.8	56.0	22.3	3.0
pc8-convey meaning accurately	30.6	60.2	7.8	1.4
pc9-know simple basic science process skills	71.2	27.4	.7	.7
pc10-acquire knowledge & information	23.2	61.9	12.8	2.1
pc11-show scientific values	35.7	54.9	8.5	.9
pc12-independent work using integrated science process skills	36.7	53.2	8.8	1.2

Table 4.15 Teachers’ opinions on the importance of the science skills that should be achieved by pupils (pc – pupil characteristics)

Almost all teachers agree that the various skills are either important or very important. However, skills (iv) ‘memorise concepts taught in preparation for their national examination (UPSR)’, (v) ‘use scientific drawing with great accuracy’ and



(vi) ‘talk about his own and others’ opinions/ideas in a reasonable way’ are perceived to be somewhat less important.

When the teachers were asked to rank the skills in order of importance, the data shown in Table 4.16 were obtained. The first, second and third preferences taken together indicate that science skill (ix) ‘the child should know some simple and basic science process skills such as observation, prediction, making inference, classifying and communication’ is seen to be the most important skill, followed by skill (xii) ‘the child should be able to plan independent work where s/he is capable of using the integrated science process skills such as making hypotheses, manipulating variables, analysing information, self- experimenting and organising his/her own time is seen as the second important skill. Skill (ii) ‘the child should be able to understand all scientific concepts taught by the teacher’ is ranked third in importance.

Item 26

Pupils’ characteristics-:	N=576 Most imp. Skill (1)	N=573 2 <sup>nd</sup> imp. Skill (2)	N=573 3 <sup>rd</sup> imp. Skill (3)	Combination of 1 <sup>st</sup> , 2 <sup>nd</sup> , 3 <sup>rd</sup> preferences
The child should be able to:				
(i) develop critical and discriminating attitudes	10.8	9.1	6.5	26.4
(ii) understand all scientific concepts taught by teachers	20.1	17.6	7.5	45.2 * (3)
(iii) handle scientific materials and specimens properly	2.3	4.0	7.7	14.
(iv) memorise concepts taught in preparation for their national examination (UPSR)	3.5	3.8	4.4	11.7
(v) use scientific drawing with great accuracy	0.3	-	1.2	1.5
(vi) talk about his own and others’ opinions/ideas in a reasonable way	0.5	0.7	1.9	3.1
(vii) develop creativity and inventiveness in some fields	0.5	2.3	3.0	5.8
(viii) convey his/her meaning clearly and accurately during discussions	1.0	3.3	3.5	7.8
(ix) know some simple and basic process skills	44.1	24.2	10.5	78.8 * (1)
(x) acquire knowledge and information from written materials	1.4	6.6	12.0	20.0
(xi) show a set of scientific values on which to base his/her behaviour	3.1	12.6	15.5	31.2
(xii) plan independent work where s/he capable of using the integrated science process skills	12.3	15.5	26.4	54.2 * (2)

Table 4.16 Teachers ranking of importance of science skills for pupils

#### ***4.5.1 Interpretation of teachers' opinions on learners' characteristics***

This is further evidence that teachers' evaluation of their practice is not based on the needs of the pupils they are teaching but reflects the aim of the curriculum guides.

The ranking of skills as 'important' or 'very important' does not reflect teachers' experience of science teaching in their schools in accordance with their pupils' backgrounds. The skills outlined by the curriculum developers are as follows (with the addition of number (iv) by the researcher):

- (i) Develop critical and discriminating attitude;
- (ii) Understand all scientific concepts taught by teachers;
- (iii) Handle scientific materials and specimens properly;
- (iv) Memorise concepts taught in the preparation for their national examination;
- (v) Use scientific drawing with great accuracy;
- (vi) Talk about his own and other's opinions/ideas in a reasonable way;
- (vii) Develop creativity and inventiveness in some field;
- (viii) Convey his meaning clearly and accurately during discussion;
- (ix) Know some simple and basic science process skills such as observation, prediction, making inference, classifying and communication;
- (x) Acquire knowledge and information from written materials, for example summarising, taking notes accurately, using the library and the computer;
- (xi) Show a set of scientific values on which to base his behaviour on, for example: honesty, sincerity and personal responsibility, tolerance, respect, appreciating others, their feelings, views and capabilities;
- (xii) planned independent work where he/she is capable of using the integrated science process skills such as making hypotheses, manipulating variables, analysing information, self-experimenting and organising his/her own time.

In fact, there are only two types of pupils' characteristics that teachers regard as very important: (ii) 'pupils should understand all scientific concepts taught by teachers' (50.6%) and (ix) 'pupils should know the simple basic science process skills' (71.2%). Interestingly, the second of these is seen as more important than the first.

This analysis reflects the exam format of the national examination in Year 6. For science, the exam has two parts. Part one consists of questions on content and part two has questions on science process skills. Inevitably, this arrangement influences teachers' views on the importance of these two characteristics for their pupils. For example, it explains the importance they attach to pupils memorising the concepts



taught in preparation for the national examination (64.4% - Table 4.15). This indicates that teachers' understanding and beliefs about science teaching are greatly influenced by exam-orientated attitudes. This is discussed further in the analysis of the classroom observation (section 5.6). Teachers' statement that concept memorisation is important contradicts their views on the importance of other characteristics. Teachers know that other skills are highlighted by the curriculum developers, but their responses indicate that the curriculum is not being implemented as intended.

When teachers were asked to rank skills, the ranking given was very much confined to science process skills. However, in the 'most important' skill category, two groups of teachers emerged: those who believe that pupils should understand the science concepts taught (20.1%) and those who believe that the simple science process skills should be gained (44.1%). This result supports the above argument. However, when the first, second and third preferences are combined, the first and the second most important skills are selected from within the science process skill domain (Table 4.16). The third important skill is the understanding of scientific concepts taught by teachers. This implies that these primary science teachers believe that pupils should be able to achieve the science process skills and science concepts in their science lesson by the end of their primary schooling. But this raises the question of whether the science process skills are actually developed in the way envisaged. This issue will be discussed later in the analysis of the classroom observation (section 5.7). Further evidence to support the argument that teachers believe pupils should understand all concepts taught and that pupils should be able to memorise these concepts is seen in the cross-tabulation in Table 4.17. It is found that the

‘information giver’ (64.6%) tends to think that pupils needs to memorise concepts as an important science skill. The ‘facilitator’ (63.7%) also agrees that this skill is important. A second ranking given to objective (v)‘ pupils should gain science knowledge and concepts’ supports the above result. This implies that despite the role teachers’ play, ‘memorising science concepts’ is considered important in order to gain science knowledge.

			teachers' most fequent role(FR)						Total
			a	b	c	d	e	f	
pupil characteritics (iv)-memorise concepts	the skill is very important	Count	33	71	14	4	5	4	131
		% within FR	15.9%	25.2%	29.2%	36.4%	62.5%	28.6%	23.0%
	the skill is important	Count	99	111	15	4	2	6	237
		% within FR	47.8%	39.4%	31.3%	36.4%	25.0%	42.9%	41.6%
	the skill is of relatively minor importance	Count	61	84	16	2	1	4	168
		% within FR	29.5%	29.8%	33.3%	18.2%	12.5%	28.6%	29.5%
	the skill is unimportant	Count	14	16	3	1			34
		% within FR	6.8%	5.7%	6.3%	9.1%			6.0%
Total		Count	207	282	48	11	8	14	570
		% within FR	100.0%	100.0%	100.0%	100.0%	100%	100%	*****

Table 4.17 A cross-tabulation of teachers’ most frequent roles and pupils’ characteristic (iv) - memorising science concept

a-facilitator, b-information giver, c-motivator, d-class controller, e-researcher, f-classroom manager

### 4.6 Teachers’ Perceptions of Barriers to Implementation of the Primary Science Curriculum

Item 27 of section 7 of the questionnaire uses 15 indicators to determine teachers’ perceptions of the barriers to implementing the primary science curriculum:

- i. Head teacher of your school;
- ii. Head of the Science Department;
- iii. District Education Officer;
- iv. Level of professional training of teachers;
- v. Level of opportunity for in-service training;
- vi. Time off to attend courses;
- vii. Level of provision of teaching material and equipment;
- viii. Co-operation among science teachers in school;
- ix. Your own level of competence;



- x. What should be taught, e.g. through syllabus, schemes of work, or PUKAL;
- xi. Teacher activity centre;
- xii. Pupil in your class;
- xiii. Number of children in your class;
- xiv. Abilities of children;
- xv. Attitudes of children.

Table 4.18 shows teachers' opinions of factors influencing their implementation of the primary science curriculum.

#### Item 27

	no influence	only little influence	some influence	a strong influence	very strong influence
	%	%	%	%	%
(i) head teacher, N=575	3.3	4.5	22.1	38.3	31.8
(ii) head of sc. dept, N=575.	2.6	3.7	19.3	46.8	27.7
(iii) district edu officer, N=574	8.2	10.6	38.2	30.8	12.2
(iv) prof training of teachers, N=573	2.6	4.7	19.7	40.5	32.5
(v) opportunity of inset, N=574	7.0	8.4	24.0	40.8	19.9
(vi) time off to attend course, N=575	7.9	9.2	37.7	33.7	11.5
(vii) level of provision, N=574	1.6	2.8	17.6	51.0	27.0
(viii) coop among teachers, N=574	2.3	1.0	15.9	51.4	29.4
(ix) own competency, N=573	.7	1.6	11.2	39.1	47.5
(x) what should be taught, N=574	.3	2.8	20.4	52.4	24.0
(xi) teacher activity centres, N=573	15.4	23.4	38.9	18.0	4.4
(xii) pupil in your classroom, N=574	.9	4.2	15.3	48.3	31.4
(xiii) number of children, N=574	2.6	4.7	22.3	45.3	25.1
(xiv) abilities of children, N=574	.7	2.1	16.6	49.0	31.7
(xv) attitudes of children, N=574	1.2	4.7	13.9	43.9	36.2

Table 4.18 Teachers' opinions of factors influencing the implementation of the curriculum

The following factors strongly influence implementation: 'head teacher' (70.1%); 'head of science department' (74.5%); 'level of professional training' (73.0%); 'level of opportunity for in-service training' (60.7%); 'level of provision of teaching materials and equipment' (78.0%); 'co-operation among teachers' (81.3%); 'what should be taught' (76.4%); 'pupils in the classroom' (79.7%); 'number of children in the classroom' (70.4%); 'abilities of children' (80.7%); and 'attitudes of children' (79.1%). There is one other factor that most teachers agree has a very strong influence — their own level of competence (86.6 %). The factors with less influence are: the district education officer (43.0%), time off to attend courses (45.2%) and teacher activity centres (22.4%).

#### ***4.6.1 Interpretation of teachers' perceptions of the barriers to implementing the primary science curriculum***

In analysing teachers' perceptions of barriers to implementation, it is found that most of the indicators listed are considered to have either a strong or very strong influence. 86.6% of teachers consider their own level of competence to be the most highly influential factor determining the implementation of the curriculum. This implies that teachers perceive that their competence reflects their abilities in teaching the subject, including their subject matter and science pedagogy knowledge. This is supported by several reports in the UK which show that improvement in subject knowledge is required for better primary science teaching (e.g. DES 1978, 1989b, Summers 1992, OFSTED 1994). It can also be linked to teachers' pedagogical content knowledge. Teachers who lack content knowledge will also lack pedagogical content knowledge. Smith and Neale (1989) conclude that teachers with limited content knowledge generate metaphors that are conceptually misleading.



They further report that ‘what was missing in most of the lessons was exactly the kind of examples, analogies and metaphors which is evidence of content knowledge in use to serve pedagogical purpose’. This shows that content and pedagogical content knowledge serve as key requirements for teaching science. The fact that a majority of Malaysian primary teachers admit that their own level of competence is the most highly influential factor acting as a barrier in implementing the curriculum indicates that their lack of such knowledge is likely to prevent the curriculum from being implemented as intended. This is supported by the fact that 60.7% of the sample consider that the level of opportunity for in-service training also has a strong influence on implementation. It could thus be inferred that teachers’ believe that possessing a high level of competence is the result of having more opportunity for in-service training. This implies in turn that teachers hope that the opportunity for in-service training will provide them with the necessary content knowledge and pedagogical content knowledge. Many researchers have shown that science teachers need to be more competent in subject matter knowledge as well as pedagogical content knowledge. For example, teachers’ subject matter knowledge is covered by research on topics such as: ‘changes and materials’ (Kruger and Summers 1989); ‘forces and their effects’ (Kruger, Palacio and Summers 1990) and ‘energy’ (Summer and Kruger 1992). These studies found that many primary teachers lack science concepts. Hence, better in-service training is needed to cover areas of conceptual understanding. Summers and Kruger (1994) reported a longitudinal study of a constructivist approach to improving primary school teachers’ subject matter knowledge in science and the impact of teachers’ content knowledge. However, Summers (1994) argues that an analysis of the content knowledge required by

teachers is not enough, and it is necessary to identify appropriate pedagogical content knowledge in relation to the particular ideas and concepts to be taught. Smith and Neale (1989) and Neale, Smith and Johnson (1990) show that teachers also lack pedagogical content knowledge. Thus, they report that only a few teachers focused on children's ideas, predictions, and explanation, and that children were rarely involved in predicting, explaining and generating ways to test ideas. This evidence shows that teachers need both content knowledge and pedagogical knowledge to teach science effectively. Hence, it is important for the Malaysian Ministry of Education, and the CDC in particular, to consider both elements when planning in-service provision.

Another factor that is rated as highly influential is 'co-operation among teachers'. 80.2% of teachers perceive this as a strong influence in determining the curriculum to be implemented. Teachers feel that collaboration and collegiality between them will help the curriculum to be implemented as intended. The teachers who were interviewed also confirmed this finding. They stated that they co-operated in teaching primary science in their respective schools. However, most said that this only happened during the initial implementation of the curriculum, and that they did not have such frequent discussions as before since they felt that they are now better equipped in teaching science. Marsh (1997) points out that if the collaboration arrangement is a 'superficial collaboration' with only a limited form of sharing which does not progress beyond advice-giving and material sharing, and where there are no deeper forms of interaction such as joint planning, observation and experimentation, this will lead to undesirable outcomes and even failure. Therefore, teachers' perceptions of co-operation among them as a highly influential factor



acting as a barrier to implementation of the curriculum are questionable. This is discussed further in Chapter 5.

**4.7 The Influence of Teachers’ Values, Beliefs and Attitudes on the Implementation of the Curriculum**

Item 28 in section 8 of the questionnaire uses 12 criteria to determine teachers’ ideologies in influencing the curriculum implementation. The criteria are:

- (i) I don’t like teaching KBSR science;
- (ii) Since KBSR, I have had to learn a lot of science;
- (iii) I feel stress when trying to complete the science syllabus;
- (iv) I don’t feel confident to teach science;
- (v) Assessment needs make it difficult to satisfy the requirements of the curriculum;
- (vi) My children need to learn through practical activities;
- (vii) KBSR science is not appropriate for my pupils;
- (viii) I was asked to teach science against my wishes;
- (ix) KBSR science is too abstract for the children I teach;
- (x) The KBSR has made me get to grips with teaching science;
- (xi) I think promoting science as a separate subject in KBSR is appropriate for children in this decade;
- (xii) KBSR science helps me to meet my pupils’ individual needs.

Table 4.19 summarises teachers’ responses on the KBSR primary science curriculum. 89.6% of teachers like to teach science, but 50.6% state that they had to learn a lot of science. Only 7.3% were not confident in their teaching. 20.5% of respondents feel stress when trying to cover the syllabus. 45.5% agree that it is difficult to satisfy the requirements of the curriculum, although 31.1% are not sure about this. They strongly disagree (89.2%) with the statement that they are asked to teach against their wishes, but a majority agree (60.3 %) that they have had to get to grips with teaching science.

These responses generally show teachers’ positive attitudes towards the science curriculum. They also have positive and strong beliefs in science KBSR. 81.6% of teachers think that science is appropriate for their pupils, and only 16.4% think that science is too abstract.

	strongly disagree	disagree	not sure	agree	strongly agree
	%	%	%	%	%
(i) I dislike teaching science KBSR,N=575	50.7	38.9	5.2	3.6	1.6
(ii) I have had to learn a lot of science, N=575	12.3	27.7	9.5	40.0	10.6
(iii) I feel stress when trying to complete the syllabus, N=574	20.2	43.9	15.4	17.0	3.5
(iv) I do not feel confident teaching science, N=573	29.6	51.9	11.2	5.9	1.4
(v) assesment need diff to satisfy, N=574	4.7	18.7	31.1	35.1	10.4
(vi) my children learn through practical activities,N=575.	1.2	6.9	8.8	63.6	19.4
(vii) science is not appropriate for my pupils,N=574	28.4	53.2	14.7	3.1	.5
(viii) I teach science against my wishes,N=574	51.7	37.5	6.1	3.5	1.2
(ix) science is too abstract for my pupils,N=573	13.7	45.8	24.0	14.7	1.7
(x)KBSR made me get to grips science, N=574	2.1	5.0	15.4	60.3	17.2
(xi) science as separate subject, N=573	1.2	6.1	13.2	51.5	28.1
(xii) science does not help me meet my pupils individual needs, N=574	.3	2.1	22.2	59.6	15.8

Table 4.19 Teachers’ ideology in influencing the implementation of primary science curriculum

Items (i), (ii), (iii), (iv), (v), (viii), (x)- are on teachers’ attitudes towards primary science;  
 Items (vii), (ix), (xi) – are on teachers’ beliefs in science KBSR;  
 Items (xii), (vi) – are on teachers’ values.

A majority (79.6%) agrees that promoting science as a separate subject in KBSR is appropriate. However, three quarters of teachers agree that science does not help them to meet the individual needs of children, although they agree that children need to learn through practical activities.

**4.7.1 Interpretation of the influence of teachers’ values, beliefs and attitudes on the implementation of the curriculum**

In analysing teachers’ attitudes towards the science KBSR, it is found that most respondents like teaching science and are not asked to teach against their wishes. They have a positive attitude towards the science KBSR. This is confirmed by the general feeling of confidence in teaching science and the absence of stress in completing the syllabus. However, most of the respondents had to acquire a lot of



science subject knowledge and they had to get to grips with their science teaching. These results supported the findings of Carre and Carter (1990). Even with such positive attitudes, teachers still need support, most importantly in instructional methods. That they have to learn a lot of science is a reflection of their science backgrounds. Most of the respondents teaching science were non-science specialists in their teacher training (68.2%). One attitude that reflects teachers' contradictory roles in teaching science is the feeling of many (45.5%) that the assessment needs of the curriculum are difficult to satisfy. As the system of education in Malaysia is tailored towards merit gained by exam results, most teachers teach towards pupils' success. Therefore, despite all the suggestion and advice given in the curriculum guide, teachers still teach to an exam format. Marsh (1997) points out that a disadvantage of external examinations is that they may encourage a concentration on teaching those aspects of a course which are most readily assessed externally, and may also encourage didactic teaching and rote learning. Another difficulty is that the assessment of science process skills is carried out for each pupil in Year 6. This only involves the Year 6 teachers in assessing these skills within the first six or seven months of the session, with results to be submitted before the national exam, which usually falls in September or October. Thus, these teachers are very busy during this year. They need to teach the science topics allocated for Year 6 and also simultaneously carry out the assessment. The implication is that teachers find it easier to teach science following an exam format. This not only saves time but also ensures that they do not suffer the consequences of adverse examination results. Thus, it is clear that primary science implementation is not as the curriculum developers hoped - when teachers concentrate on producing pupils with good

examination results, the science pedagogical aspects are diminished. The main concern is the exam, and teaching becomes ‘traditional’.

Most teachers agree that the science KBSR is appropriate for their pupils and that it is not too abstract. They also feel that promoting science as a separate subject is appropriate. We can generalise that teachers agree with the changes and that the curriculum innovation has been accepted by teachers who are willing to teach science rather than the old ‘Man and Environment’ curriculum. This is also confirmed by the sample interviewed. They agree with the changes and accept the curriculum innovation. If teachers were not confronted with examination requirements, the curriculum might well be implemented as intended. If teachers believe that a change is beneficial, then the curriculum innovation will be sustained and not modified by teachers, for example because of examination needs. The implication here is that the Examination Board, the curriculum developers, and other related agencies should reconsider this situation so that teacher support will be sustained and the curriculum innovation will be implemented as intended.

#### **4.8 Teachers’ Opinions on the Idea of ‘Pupils as Active Learners’**

72.3% of teachers agree that the notion of ‘pupils as active learners’ is applied in their classroom. The proportion disagreeing is relatively small, but it is still important to look at the reasons for this disagreement. This result tallies with responses to item 13 (viii) in section 3 of the questionnaire (Table 4.7), which asked teachers whether or not they find difficulty in using all ideas their pupils generate during a teaching session. 46.7% of teachers (Table 4.7) do not find difficulty. Pupils are thus able to generate ideas and opinions, and are able to test them. However, the 20.8% teachers whose pupils are not active learners gave various reasons as follows:



- Pupils are very much teacher dependent
- Pupils have low science knowledge
- Pupils' attitudes
- Pupils have low ability
- Depends on topic taught
- Pupils have no ability to generate ideas
- Pupils have low thinking skills
- Pupils come from low income family
- Due to time constraint
- School lacks apparatus and materials
- Exam oriented
- Rural areas are not exposed to science

These categories, developed from the open-ended question (item 15), do give some information on the real situation in schools. This will be discussed later (section 5.331[b, c]) when comparing the questionnaire results with fieldwork (interview and observation) data.

**(a) Teachers' reasons for not applying the idea of 'pupils as active learners'.**

The idea that **(a) pupils are too dependent on teachers** stems from a belief that pupils need to be guided and that a majority of pupils will accept what the teacher says. Pupils in general do not have any science reference books and so depend on teachers for ideas. Furthermore, teachers believe that they have to give information because these pupils have no prior ideas about the lessons. Teachers also believe that primary school children are not able to generate ideas without the teachers' help and guidance. Some teachers also claim that this is not only for low-ability, but also for average, pupils. A number of teachers also claim that a majority of pupils are passive and depend on teachers as information givers. Other reasons given are that pupils are not exposed to science information and material, and so teachers have a more central role in guiding pupils.

For category **(b) pupils have low science knowledge**, teachers feel that this is due to their environment, i.e. in the rural areas there are limited resources, references and

printed material on science. Pupils in the rural areas are therefore considered less motivated to read, resulting in a low science knowledge base. They also relate this to the pupils' ability. They equate these pupils with **(c) low ability**, and the pupils' ideas are seen as irrelevant and illogical. Some respondents even state that these pupils have no ideas to apply and no ability to test ideas. They also feel that these pupils lack the 3R skills. Teachers also claim that some pupils have a low innate ability due to their rural environment. Others state that these pupils are so weak in their studies that they always need teachers' guidance.

For the category **(d) pupils' attitude**, teachers claim that pupils are passive, disinclined to read, are not interested, have less initiative in generating ideas, and are different in their thinking, diligence and interest. Teachers also state that pupils in rural areas have less interest in science because of their lower exposure to science and their limited resources. Some teachers also claim that students do not respond to teachers' questions, and this slows down the teaching and learning processes.

A few teachers also mentioned **(e) depends on topic taught** as one of the reasons for not applying the idea of pupils as active learners. But most teachers stated **(f) pupils have no ability to generate ideas**. They believe that pupils are not up to the standard and cannot actively take part in the discussion. For category **(g), low thinking skill**, teachers claimed that pupils are not exposed to thinking skills and, because of pupils' immaturity, their ideas contradict those of the topic taught, especially in Year 4.

Teachers stated that pupils from rural areas are of **(h) low-income status**. They are thus deprived of science reference books because they cannot afford to buy them.



Accordingly, such pupils have difficulty in generating ideas due to their lack of reading.

From the teachers' perspective, (i) **time constraint** is another reason for not using the idea of 'pupils as active learners' in their classrooms. This includes the time needed to finish the syllabus, teachers' other professional duties, the broad scope of the subject and lack of time to develop ideas. One or two teachers referred to other factors: (j) the school's lack of apparatus, (k) being exam-oriented and (l) condition in rural areas.

All these factors are very much related to one another. The link is the belief teachers have in pupils' ability. Often teachers' state that pupils have low ability, cannot think, do not have the ability to generate ideas, and depend too much on their teachers. Teachers feel it is their duty to teach pupils so that they gain knowledge priority. Teachers' reasons for pupils' deficiencies are mainly environmental: low-income family status, lack of references books either at home or in schools, living in rural areas; and also pupils' attitudes. These all militate against applying the idea of 'pupils as active learners'.

(b) Teachers' reasons for being able to apply the idea of 'pupils as active learners'

Those teachers who agree that the idea of 'pupils as active learners' is applicable to their classroom (72.3%) propose several reasons:

- Ability to generate ideas
- Applicable ideas
- Brave
- Confidence
- Creative and critical pupils
- Effective teaching
- Emphasis by curriculum
- Enhances the science process skills
- Fun learning environment
- Help other pupils (i.e average and weak pupils)
- Increased interest
- Independent pupils
- Interaction

- It's an inquiry approach
- Makes the teaching and learning process easier
- Meaningful learning
- Motivate other pupils
- Pupils' ability/good pupils
- Pupils have prior knowledge
- Pupils' involvement
- Sharing of ideas
- Talent
- Teacher gained knowledge
- Test pupils understanding and increase understanding of science concepts
- Thinking skills

Most teachers use two broad perspectives to generate reasons why pupils can be active learners: the **pupils' perspective** and the **teachers' perspectives**.

From the **pupils' perspective**, some pupils are seen to have all the qualities enabling them to be active learners, e.g. talent, confidence, interest, high thinking skills, able to interact, like to be involved, able to help others, have prior knowledge, independent, high curiosity, able to motivate others, able to share ideas, brave, creative and critical, highly able, and able to generate ideas.

From the **teachers' perspective**, teachers either see the advantages of using the ideas in their classroom or they are conforming to the suggestions given in the curriculum guidebook. The advantages of applying the idea of pupils as active learners are: teacher gains additional information and knowledge from pupils' ideas; it makes the teaching and learning process easier; there is a fun learning environment. By contrast, conformity to the guidebook is reflected in: emphasised by curriculum; it is an inquiry approach; to enhance the science process skills and to test or evaluate pupils' understanding. Those teachers who believe children should learn science by being active learners so that **learning is meaningful** understand the basic idea of 'pupils as active learners'. When teachers propose the concept of meaningful learning, they mean that their pupils will use all the above qualities to gain knowledge and understanding of science concepts and facts. Hence, if teachers



believe in meaningful learning they will apply the idea of ‘pupils as active learners’ to both high-ability and low-ability pupils.

These responses confirm that Malaysian primary science teachers know the intended curriculum and try to implement it in ways they understand. However, the 20.8 % of teachers who feel that they cannot apply the ideas must not be overlooked. They equate this with teaching average or low-ability classes. These pupils will always be a majority in the school population; thus there is a reasonable doubt whether 72.3% of teachers are really applying the ideas in their respective classes. This issue is discussed further in Chapter 5.

## **Chapter 5      REPORT AND ANALYSIS OF QUALITATIVE DATA**

### **5.1 Introduction**

This chapter will give an account of the report and analysis of the qualitative data. The data analysed consist of interviews and classroom observations. An attempt is made to explain the findings, which are analysed under the following headings:

- teachers' views and opinions on primary science objectives;
- teachers' perceptions on the nature of primary science teaching;
- teachers' views and opinions on barriers to implementation of the primary science curriculum;
- teachers' personal views on the primary science curriculum;
- teachers' ideology in relation to the primary science curriculum;
- classroom observation data analysis

### **5.2 Teachers' Views and Opinions on the Primary Science Objectives**

To explore teachers' opinions on the primary science objectives as stated in the curriculum guide, a number of related questions were asked during the interviews. The aim was to identify teachers' perceptions of the most important and least important of the objectives, their perceptions of the easily implemented objectives and those that are difficult to implement, the objectives which they find difficult to understand, and their global opinions of the primary science objectives.

#### ***5.2.1 Teachers' opinions of the most important objectives***

A summary of these opinions is given in Table 5.0. The 14 teachers clearly perceived objective (i) to be the most important, followed by objectives (v) and (iii). One



respondent thought that objective (vi) was the most important. These findings should be reflected in the observation of teaching strategies to develop thinking skills.

However, several teachers (seven) believe that pupils should gain knowledge and understanding of scientific concepts and facts in order to understand themselves and their environment.

N=14

Obj	Statement	No. of teachers ranking it as most important	No. of teachers ranking it as 2 <sup>nd</sup> most important	Combination of first and second preferences
(i)	Develop thinking skills to increase intellectual capability	6	4	10
(v)	Gain knowledge and understanding of the scientific concepts and facts in order to understand themselves and their environment	4	3	7
(iii)	Develop scientific skills in an inquiring manner	3	3	6
(vi)	Develop the ability to solve problems and make responsible decisions	1	2	3
(ii)	Increase interest in the environment	0	2	2

Table 5.0 Teachers’ perceptions of the important objectives in primary science

There is some indication that the result in Table 5.0 is related to pupils’ abilities.

Teachers believe that the objective is achievable by able pupils. Thus teachers perceive that if pupils cannot achieve the other objectives, at least they will develop science knowledge. Three out of 14 teachers think that objective (vi) should be the important objective, whereas two teachers think that objective (ii) should also be considered important.

We can deduce from this data that the objectives that teachers rank as the most important reflect their understanding of the way in which the science curriculum provides pupils with thinking skills and scientific skills in order to assimilate the content. Objectives (i), (v) and (iii), which are selected as important, indicate that

teachers know that they need to provide pupils with activities to process information, e.g. by involving them in organising and finding relationships in the information they encounter rather than being the passive recipients of teacher delivered-bodies of knowledge. But the remaining question is whether objective (i) is applied and realised in science lessons as indicated by the data, whether objective (v) is given more emphasis to ensure that the content is transmitted to pupils. This raises the question of whether teachers are aware that these objectives need to be integrated during the lesson in order for pupils to gain the content – scientific concepts. Skills such as thinking skills, problem-solving and science process skills need to be integrated while teaching the lesson. It can be argued that teachers select important objectives mainly within the development of the cognitive domain in science. However, two of the 14 teachers think that objective (ii) ‘increase interest in the environment’ is important. This response reflects an ambiguity in teachers’ perception of the most important domain in science education. It indicates that it is grouped under the affective domain of scientific educational goals, i.e. it is attitudinal and does not have pupils’ intellectual growth as the primary focus. This evidence suggests that teachers need an in-depth understanding of the underpinning principles of primary science education in order to implement it as intended. Taking the first and second preferences (Table 5.1) together shows that nine out of 14 teachers think that objective (vii) is the least important followed by objectives (viii) and (ii). Four teachers think that objective (iv) is the least important, and another three think that objective (ix) is the least important.



N=14

Obj.	Statement	No. of teachers ranking it as the least important	No. of teachers ranking it as the 2 <sup>nd</sup> least important	Combination of first and second preferences
(vii)	Increase the ability to cope with the latest contribution in science and technology	6	3	9
(viii)	Practice good moral values and scientific attitudes	5	1	6
(ii)	Increase interest in environment	1	4	5
(iv)	Appreciate the arrangement and orderliness of nature	1	3	4
(ix)	Appreciate the contribution of science and technology for the welfare of our life	1	2	3
(vi)	Develop the ability to solve problems and make responsible decisions	0	1	1

Table 5.1 Teachers’ perceptions of the least important objectives in primary science

We can deduce that teachers’ selections of the least important objectives are within the affective domain. Surprisingly one teacher selected objective (vi) ‘ to develop the ability to solve problems and make decisions’ as the least important objective. Two implications can be drawn here. First, when objective (vi) is ranked as the least important objective, it implies that the teacher does not prioritise this objective and does not use it as a teaching strategy. Secondly, the teacher does not know or understand how to use problem-solving in teaching primary science.

According to Gatt (2000), in problem-solving:

*‘Children are given time to think about the problem presented and to come up with possible solutions. The scientific concept or concepts are identified. The rest of the activities organised will then focus on ways to investigate these scientific phenomena in order to test the suggested solutions. The nature of the problem set will be influenced by the age and experience of the children involved. Should the problem be too demanding or too easy it will lose its effectiveness. ’ (p.8)*

As suggested by Gatt (2000), time should be given for children to think about the problem presented and to show that it has meaning for them. Furthermore, the situation chosen must be relevant to the children’s experience. In the context of the

Malaysian primary science teachers, to give children time to think would mean that the teachers planned activity would not be completed, and this would interrupt teachers' semester scheme of work.

Watts (1991) gives a series of answers to the question 'why use problem-solving?', one of which is that 'it is a vehicle for teaching many scientific skills, and for reaching the content aspects of science'. Therefore, when objective (vi) is ranked as the least important, this implies that the teacher does not perceive that problem-solving is applicable as a teaching strategy to develop pupils' scientific skills, thinking skills and understanding of scientific concepts. Yet teachers need to emphasise the development of pupils' intellectual growth through a problem-solving approach. This supports the data on teachers' ranking of the important objectives. Only three out of 14 teachers ranked objective (vi) as important.

Finally, the results show that some teachers need to be enlightened about the three domains of educational goal: cognitive, affective, and psychomotor (Bloom *et al.* 1956, Bloom, Krathwol and Masia 1964). This will help teachers to identify their priority for pupils' development in primary science. Generally, the respondents agree that the objectives of the affective domain are the least important and those of the cognitive domain are the most important.

### ***5.2.2 Teachers' opinions on the degree of difficulty in implementing primary science objectives***

#### **(a) Teachers' perceptions of the objectives that are most easily implemented**

Appendix 2 indicates that the easiest objectives to be implemented are (ii) and (ix) followed by (viii). Other objectives regarded as easy to implement, but by fewer respondents, are (iv), (v), (vi) and (vii).



The common reason given for the ease of implementation of objective (ii) is that it is easy to get pupils interested in the environment. However, the respondents provided a range of reasons why this might be. Two claimed that practical activity or experiment, which is easily achieved, will increase pupils' interest. Another related objective (ii) to a teaching topic in the curriculum, i.e. living things. Yet another claimed that it is done indirectly. One suggested that it is interconnected to other subjects, and two related it to the prior knowledge that pupils have. Therefore, even though most teachers agree that objective (ii) is the easiest to implement, their reasons vary according to their understanding.

Almost all the objectives [i.e. (ii), (iv), (vii), (viii), (ix)] mentioned are in the affective domain. However, some respondents selected objectives (v) and (vi) as the easiest to implement. These two are in the cognitive domain. Two reasons for choosing objective (v) are:

*'...it is easy to gain knowledge in various ways.' (MY)*

*'...at least 75% of my pupils have prior knowledge of the topics.' (DZ)*

This suggests that MY believes that pupils can be given a variety of activities to gain knowledge, and so his experience and pedagogical knowledge help him to implement this objective easily compared with other respondents who feel that the affective domain objectives are more easily implemented. However, another respondent's reason for saying objective (v) is easy to implement is related to his pupils. He believes that 75% of his pupils have some prior knowledge about the topics he is teaching, thereby making it easier to implement this objective. Only one respondent selected objective (vi) as easy to implement. Her reason is:

*'.....usually pupils are able to solve problems with my guidance.' (NH)*

This indicates that NH’s understanding of problem-solving activity is not determined by pupils’ perceptions of the problem and their participation in the choice and formulation of problems, but rather it is based on teacher’s determination of the problem and provision of activities to solve the problem, with the lesson being teacher guided and so easier to implement. Hadfield (cited in Watts, 1991) explains that in problem-orientated structured teaching, it is the task of the teacher to structure the material in such a way that problem-solving situations arise in the course of the lessons. So, although the context is that provided by the teacher, the class generates the problems themselves. Watts (1991) further observes that problems are better solved if the solver generates them, i.e. if they are his/her OWN problems (p. 37).

**(b) Teachers’ perceptions of the objectives which are difficult to implement**

By analysing Appendix 3, the objectives that teachers feel are difficult to implement can be summarised in the Table 5.9 below:

Obj	Statement	N=14
(iii)	Develop scientific skills in an inquiring manner	13
(i)	Develop thinking skills to increase intellectual capability	9
(v)	Gain knowledge and understanding of scientific concepts and facts in order to understand themselves and their environment	8
(vi)	Develop the ability to solve problems and make responsible decisions	7

**Table 5.9 Teachers’ perceptions of objectives that are difficult to implement**

Thirteen out of 14 teachers agree that objective (iii) is difficult to implement. There are various reasons for this, falling into three categories:

- pupils’ ability
- teachers’ own lack of knowledge
- pupils’ previous learning techniques (the ‘spoon-feeding’ syndrome)

Most respondents claim that the implementation of objective (iii) depends on pupils’ abilities, and thus it is easier for higher-ability classes and more difficult for the weaker classes. Only two respondents admit that it is their own lack of knowledge



that causes them difficulty in implementing this objective. Another two feel that the difficulty is due to the way pupils have been trained to learn before entering Year 4. The teachers perceive that pupils have been spoon-fed, thus making it difficult for them to do work on their own. They still need teachers' clear instructions on what to do and are still unable to make their own decisions.

Another objective which teachers consider difficult to implement is objective (i). Similar reasons were given as for objective (iii) above. Mostly, they emphasise pupils' ability and their lack of prior knowledge due to insufficient reading. Another reason given is pupils' attitude, i.e. they are too lazy. The implication from these responses is that teachers consider that their pupils do not want to think for themselves, but merely want to be told what to do. This results in situations where pupils' feel that being told is more ordered and less demanding than being forced to make decisions and draw conclusions.

The selection of objectives (i) and (iii) suggests that teachers implicitly understand the relationship between science process skills and thinking skills even though this is not explicitly mentioned by the respondents, except one:

*'Pupils also need to think to use the scientific skills. So to work in an inquiry manner, I have to tell them what to do.'* (NU)

In conclusion, it is possible to say that most of these primary science teachers do not look at the curriculum globally but see it as compartmentalised. Teachers do not perceive these two objectives [(i) and (iii)] as subsets of each other, but as separate entities, thus compounding their difficulties.

Another objective that teachers feel is difficult to implement is objective (v). All eight respondents agree that this is because of the pupils' ability. They claim that even high-ability pupils have difficulty in understanding facts and concepts in

science. Teachers feel that they need to explain science concepts and facts continually, with constant consolidation to make certain that pupils understand them. The clear implication is that teachers do not think science facts and concepts are gained through objectives (i) and (iii) but rather through didactic transmission. Again, the respondents see the objectives as being compartmentalised. Half the respondents also claim that objective (vi) is difficult to implement. Again, they point to pupils' ability and attitude as the source of the difficulty. They feel that pupils have low self-esteem and are not confident enough to solve problems on their own. Another implication is that teachers might not have the science pedagogical knowledge to teach science to less-able children. Bianchi (1999) suggests that:

*'Structuring all facets of the science lesson gives less-able children improved opportunity to illustrate a deeper understanding of the purpose, processes and underlying concepts involved' (p.20).*

Therefore instead of teachers admitting that they lack the knowledge to implement the science objectives either for high-ability or less-able pupils, children become the targets of difficulties in teaching science.

It seems that teachers have particular difficulty with the objectives in the cognitive domain. They do not look at them as a whole. If they were shown the connections, they might be better equipped to implement the objectives. The cognitive domain, that teachers find difficult to implement, includes key scientific concepts, thinking skills, scientific skills and problem-solving techniques. These elements require teachers' content knowledge (subject matter knowledge) and pedagogical content knowledge (Shulman, 1987). This shows that the difficulties teachers face in implementing the objectives are caused by insufficient knowledge of subject matter and science pedagogy. In UK, OFSTED (1994) reported that in 'half the lessons



where pupils achievements were unsatisfactory, poor pedagogic skills combined with weak subject knowledge on the teachers part' (para 12, p.3). Thus, Malaysian primary science teachers' lack of content and pedagogical content knowledge undoubtedly affect pupils' development and intellectual growth in science. It seems that the orientation courses they attended failed to cover this aspect in sufficient depth. In addition, the curriculum guide prepared by the CDC does not provide the necessary depth of understanding of the objectives for successful implementation. Kruger, Summers and Palacio (1990) suggests that INSET for primary science in the National Curriculum in England and Wales might not perceive teachers' real needs. They state that the IPSE (Initiatives in Primary Science: An Evaluation 1988) report on in-service training points out that 'teachers' lack of knowledge was an aspect of the teaching of science which had not been adequately addressed within these training programmes and this omission constituted a problem'. Russell *et al.* (1992) point out that even though teachers described themselves as having sufficient knowledge or had some science qualification, they expressed doubts about teaching science effectively. They further state:

*'Their difficulties lay in developing an approach to teach science which they accepted as good primary practice, an approach which offers young children the scientific experiences they need, an approach which takes account of children's current level of understanding and which enables teachers to identify how children's thinking might progress.'* (p.142)

This situation is similar to the orientation courses (in-service courses) attended by teachers for the Malaysian science KBSR. The courses did not address teachers' needs in science content and pedagogical content knowledge, thus reflecting the difficulty in implementing the objectives which are the elements of this knowledge.

(c) Teachers' perceptions of the objectives they found difficult to understand

Appendix 4 shows that nine of 14 respondents do not understand objective (viii), followed by two respondents for objective (iv), and one respondent for objective (ii), whereas three respondents understand all objectives. The common reason given is that the teachers do not understand what the objectives really mean. Hence, they cannot possibly implement them. This indicates that the mandated curriculum is not implemented due to insufficient information and explanation and the teachers' inability to construct the intended meaning from written materials (Appleton cited in Biddulph and Carr, 1991). Another implication is that CDC has to revise the curriculum guide in order for the objectives of the primary science curriculum to be made clearer and more precise.

### ***5.2.3 Teachers' reaction towards changing the objectives***

Eight respondents do not want to make any changes, whereas six respondents would like to see some changes in the objectives of the primary science curriculum.

Teachers' reactions to the question vary. Some want the objectives to be retained but they qualify this according to their understanding:

*'I agree with all the objectives but perhaps the statements need to be rephrased for clarification and the curriculum guide needs to provide more detail.'* (MY)

*'No changes but perhaps some ranking in importance for the pupils.'* (DZ)

Other respondents accept the objectives as they are and see no reason for change:

*'No changes.....I don't know.....It's okay, the objectives look too much but I would not know how to formulate any objectives so I accept them.'* (RU)

*'Retain all and give more emphasis on thinking skills and look at their importance.'* (BA)

*'All are acceptable, it covers all. Do not add to them but reduce the requirements for the weaker pupils. But this creates further problems so perhaps they should not change.'* (NU)

Two respondents offer critical views:



*'It is enough and to achieve it will take time. We cannot achieve it all at once but only gradually and slowly, it takes time.'* (SS)

*'To me all the objectives are good. All of it can be taught and we can select according to the topics we teach.'* (NH)

One respondent gives a straightforward response with no explanation.

*'No changes but I don't understand objective (vii) increase their ability to cope with the latest contributions and innovations in science and technology.'* (SH)

In general, teachers accept the objectives of the primary science curriculum but there is clearly some dissatisfaction. Thus, the CDC needs to look again at the objectives and consider further revisions to develop a better understanding by teachers so that implementation of the curriculum can proceed as intended.

For those respondents who want changes to the objectives, there are two categories of change: additional objectives and the rejection/reduction of some objectives. Two respondents want to reject objective (vii); two respondents want to reduce some of the science process skills in objective (iii); and one respondent suggested two separate science syllabuses: one for able pupils and one for weaker pupils. Only one respondent wants to add an objective: this concerns pupils' creativity and inventiveness, to ensure that this aspect of science is sufficiently covered. She also suggests a competition related to this objective at school level. Those respondents who want the science process skills reduced claim that it is too much to cover at primary level. At present 12 science process skills are to be taught to primary pupils. The respondents suggest that about half of these should be left until secondary school.

In general, very few teachers feel able to voice their difficulties in implementing the objectives. In other contexts many teachers voice their difficulties in making pupils understand and master the science process skills. There is a practical exam on the

skills, and questions on science process skills are included in the national examination. Therefore teachers are forced to teach the science process skills due to the examination requirements, and it is very surprising that not many respondents are critical of this.

#### ***5.2.4 Teachers' personal opinions on the objectives of the primary science curriculum***

In analysing the answers given by respondents, three patterns of teachers' perceptions emerge. One of the 14 respondents feels that the objectives are too complex to be achievable by her pupils. This is her response:

*'The overall objective that I see from this (curriculum guide) is that it wants to develop.....it is the NEP, to develop a good balanced human being so it is the overall development....It is good....but to see it as overall it is too difficult. To achieve it all is not possible. For me it's like ...the aim is too.... too perfect and I cannot apply it all to my pupils.'* (RU)

Thus, RU's perception of the objectives is that they are not in total agreement with her classroom teaching. She finds that the objectives are good. As a teacher, she knows that the objectives are intended to produce primary school children with science knowledge within their overall development but the tone of her response shows that in her view the objectives are too 'high' for her pupils to achieve. Another implication is that only some of the objectives can be achieved. This is shown by her response 'To achieve it all is not possible'.

The second pattern shows eight respondents agree with the primary science objectives, with three key subcategories emerging:

- to produce a scientific community (five respondents)
- suitable for children (two respondents)
- teacher-centred (one respondent)

The respondents whose perception of the primary science is to develop a scientific community were greatly influenced by the national agenda for producing a scientifically literate community. Thus their responses show that the objectives are



set-up (legislated) for the development of scientifically oriented pupils. Some link the objectives with the Ministry's aim or the vision 2020 as put forward by the Prime Minister of Malaysia (Sarji 1993). In the words of one respondent:

*'In my opinion the main aim of primary science education is to develop a community that has a scientific culture and scientific skills. So it is important to prepare future scientists for use in the year 2020. So in general, the objectives are consistent with the Ministry's vision, especially objectives (i) and (ii).'* (SO)

Another respondent said:

*'I feel it coincides precisely with the ministry's aim in developing pupils in the science and technology fields and it can be achieved. It covers all aspects including knowledge, values, experiment and can be applied in pupils' everyday life.'* (MA)

Even those who do not emphasise the national agenda, believe that the primary science objectives should aim to produce a scientifically literate community:

*'For me the objectives are suitable for the primary school level. It is logical and practical, like the thinking skill we can develop in them.....It's like an exposure to produce a scientific community.'* (AA)

*'Looking at the present curriculum, it is more towards developing a community literate in science and technology. So primary science is formulated towards the formation of a scientific community. As a whole the objectives look achievable.'* (BA)

*'As I see it.... Not in detail, but as a whole, it is suitable for the school environment, I find it covers the need of pupils to live in the scientific and technological era.'* (MY)

However, one respondent does not see the objectives as globally intended to produce pupils literate in science. She endorses the teacher-centred concept:

*'It can be achieved in the teaching and learning process, so if my teaching is successful so will be the objectives.'* (ZA)

This respondent focuses only on the classroom situation, suggesting that her priority is her own teaching and pedagogical skills. She gives priority to her achievements in classroom teaching, and her pedagogical knowledge relates to her beliefs, values and attitudes; she is the main actor in the classroom. This is bound to condition her implementation of the curriculum. The main concern here is the way she teaches

science. It suggests that 'successful teaching' is essentially teaching science as a teacher-directed subject (Cronin-Jones 1991, Russel *et al.*1992).

The third pattern is represented by the five respondents who feel that the objectives are only achievable for pupils of high-ability:

*'In my opinion the primary science objectives are good and cover all the years but it depends. For example in Years 4, 5 and 6 not all the objectives are applicable; it depends on the topics taught and also on the class. The good classes will be able to achieve them, so it depends on the pupils- they cannot achieve all, but only a part. Good-ability pupils are able to achieve, but average pupils need guidance; without guidance they are lost.'* (NH)

*'From the objectives legislated by the Ministry, I found that they are partly achievable by our pupils. For example they are able to use scientific attitudes in their life. They are able to use thinking skills and appreciate values, for example the importance of the environment, and they also know more about technology in their everyday life based on science. So this means that the objectives are achievable by pupils. Partly, I mean some pupils are able to achieve all the objectives and some can only achieve some of the objectives.'* (DZ)

Teacher perceptions of the objectives are pupil-related. From their experience in implementing the curriculum, these respondents find that the objectives are mainly achieved by high-ability pupils, and they consider that they are not suitable for the weak ones. Thus, a key question is: what can these teachers do to help these weaker pupils to learn more effectively in science lessons? (See, for example, Bianchi 1999; Bell 1999.)

To summarise teachers' views and opinions on the primary science objectives, it seems that teachers need the particular goals of science learning to be spelled out clearly. A justification of the goals of primary science education needs to be made more precise. A fundamental question that Malaysian science educators need to address is 'What learning do we want to achieve through primary science education?' As Ratcliffe (1998) points out:

*'We need to be clear about how learning any particular science topic is going to assist the future citizen and also give consideration to the pupils' role in determining the direction of their own learning'* (p.10)



This implies that the Malaysian CDC needs to review the primary science curriculum guide in order to help teachers teach certain science topics to children with a clear understanding of the goals of science education. Therefore, before the teachers are able to implement the intended objectives of the primary science curriculum, they need to have a grounded understanding of the purpose of primary science education. It is essential for teachers to understand why we consider these objectives to be so important in pupils’ education, and it is also important for teachers to understand how to develop these objectives from a science education perspective.

**5.3 Teachers’ Perceptions on the Nature of Primary Science Teaching**

In order to analyse the perceptions teachers hold on the nature of primary science teaching and to determine whether those perceptions correspond to those suggested by the curriculum innovators, we focus on the following issues:

- teachers’ views on how children learn science;
- effective teaching strategies;
- the approaches most frequently used by teachers;
- teachers’ opinions on a constructivist learning approach;
- teachers’ knowledge of learners’ characteristics in science lessons

**5.3.1 Teachers’ views on how children learn science**

Learn through:	Number of respondent n =14
Activity-based learning	8
Information- finding	4
Experience	1
Information-giving	1

Table 5.10 Teachers’ responses on how children learn science

Table 5.10 shows that half of the respondents agree that children learn science through activity-based learning. Teachers attach various meanings to activity-based

learning, but the main idea is of pupils carrying out an activity, which teachers refer to as an experiment (practical activity). These teachers believe that children learn science through practical activity, which helps them to understand the lesson concepts due to high level of pupil involvement in the lesson. Teachers also include problem-solving activity and hands-on activity as important aspects of this type of learning. These teachers believe, through their own experience and implicit pedagogical knowledge, that children should learn science through activity. This view inevitably affects their teaching strategies. However, one respondent, who also feels that activity is important when children learn science, holds a different point of view:

*'Pupils must make an effort. When they get an idea, they must do inquiry- discovery. This is like the way we studied before. We get a theory and then we have to prove it. I feel that when they get ideas on how scientists did it, then they can change it to a new discovery. But for the primary level I think they just need to prove the theory. They have not reached the level of building up a theory, so now they do experiments to prove the theory so they can understand it faster, and this will stimulate their interest to discover.'* (MY)

The implication of this statement is that when pupils only need to prove an already proven theory, ideas of inquiry-discovery are already distorted. For this teacher, pupils only do a prescribed practical activity prepared by teachers. This is what the teachers did when observed. The belief that practical activity is the best way for children to learn science is due to their experience. The teachers have found that children understand science concepts better, and that pupils remember better, if they carry out activities themselves. However, it might be that the understanding of the prescribed activity is due to the emphasis placed on a guided approach in the syllabus, and this approach can be more of a recipe method than a guided inquiry.



Four teachers state that children learn science by searching for information. This is generally done by reading science reference books and materials. As three respondents observed:

*'First we need to attract pupils' interest in science. This will influence them to put an effort into learning and find books or any additional material to further their knowledge; so they find information and teachers do not have to give all.'* (ZA)

*'The best way is for pupils to find their own information, then the teacher can give a little bit more content than is required. Then they go home and find out more, but this requires a lot of sources of information.'* (RU)

*'Pupils need to do a lot of reading of science material, books and magazine so that they learn science effectively.'* (SH)

Clearly, these teachers believe in the importance of science content. They believe that pupils will acquire more science information by searching for it and teachers will have less responsibility to provide content.

Only one respondent believes that children learn science from their everyday experiences:

*'Children learn science from experience, what they observe from their surroundings. Perhaps what they observe they do not understand, so the teacher will develop their ideas in the classroom and correct their misconceptions and add to these with other activities.'* (SO)

One respondent believes that children learn science by teachers giving them information:

*'Teachers should give information first if pupils do not have prior knowledge or something, so the teacher gives notes to pupils directly. If pupils have prior knowledge, the teacher should interconnect this knowledge with the lesson.'* (BA)

In summarising the views teachers have on the way children learn science, it seems from the evidence above that most teachers look at it from their own perspective and not from the pupils'. They already have a preconceived idea that when doing an activity, especially a prescribed experiment, children learn science. Their responses reflect their practice of preparing an activity for their pupils. Pupils must be able to

find or search for information. This coincides with the teachers' belief in the importance of acquiring content through information-searching. When one respondent stressed that she must give information when first starting the lesson, she implied that pupils get the science content and concepts which she hopes to transmit. This is what is meant by teachers not seeing things from the pupils' perspectives. A majority of teachers do not perceive that learning is a 'change' of ideas. Only one respondent believes that children's ideas should be used, and she feels that as a teacher she needs to correct the misconceptions pupils have. According to Harlen's (1993b) model of the development of children's ideas, ideas from previous experience are called upon in trying to make sense of a new experience, and there are several ideas which can be used in a particular situation. This model represents learning as a 'change' of ideas. We found evidence of only one teacher implicitly understanding that pupils bring with them an alternative framework that needs to be modified, and this attitude inevitably affects her teaching approach, which is inclined towards constructivism. The overwhelming evidence is that most respondents do not believe in, or do not have an inclination towards, such an approach.

### ***5.3.2 The most effective teaching strategies for helping children learn science***

Seven out of 14 respondents agree that experiment is the most effective teaching strategy for helping children learn science. This is consistent with their views on children learning science through activity-based work. However, the kind of experiment that teachers refer to is actually a structured practical activity, because in the Malaysian context pupils are instructed in the method and do not come up with a



fair test design or investigation as encouraged by the NC of England and Wales (DfE 1995). This can be seen in one teacher's response:

*'Mostly it is experiment and field work. First, if we do an experiment that involves pupils, a teacher only gives instructions and guidance. One more thing that I see is pupils' understanding; they can understand faster compared to when I teach without an experiment. In experiments they carry it out by themselves. They observe, listen to what they want to know. They do it themselves. Usually it is like that.'* (SS)

Another strategy these teachers regard as effective in helping pupils learn science is discussion. Five of these teachers emphasise *group* discussion. The teachers initially give questions to pupils to discuss in a group; a group representative presents the topic to the class, followed by a question-answer session. These respondents feel that through group discussion pupils become more confident in sharing their ideas with their group, and they therefore understand things better, thereby facilitating effective science learning. Two respondents have a different point of view about the most effective strategies for teaching science. One emphasises co-operative learning as a mean to allow pupils to share information that is sometimes too difficult for pupils to cope with individually. Another respondent believes that simulation is the most effective way to help children learn science. Pupils enjoy this method and are able to picture it in their minds, thus leading to better understanding.

The evidence thus suggests that teachers see the most effective strategies as experiment (practical activity) and discussion. However, these two strategies are teacher-guided, and instructions given have to be followed closely by pupils. There is evidence that they confine pupils to what has been set by the teacher, and there is no indication of meaningful learning through activities planned by pupils themselves. Teachers generally believe that pupils learn science effectively without them questioning the pupils' initial ideas. Indeed, teachers are not generally aware

that pupils have initial ideas which must be taken into account. There is no doubt that the strategies used are encouraged by the simple explanation in the curriculum guide. In this sense, teachers implement the curriculum as specified by the curriculum guide, but they lack the science pedagogical knowledge to teach science from a pupil's perspective. Teachers identify pupils' ideas through questions at the start of the lesson. This is what teachers understand as 'probing pupils' prior knowledge' but this is not followed up in a meaningful way. It is still a recipe approach. The influence of children's existing ideas on their learning in science is becoming increasingly recognised (Driver 1983, Driver, Guesne and Tiberghien, 1985, Bradley 1996, Harlen 1993a, 1996, Harlen and Jelly 1997, McGuigan and Schilling 1997, Watt 1998, Hodson 1998). Therefore, Malaysian primary science teachers need to understand the effectiveness of using children's ideas in science learning to develop pupils' conceptual understanding in science. With this understanding, teachers might be able to develop a constructivist approach.

### ***5.3.3 Teachers' science pedagogical knowledge in helping them implement the curriculum***

(a) The types of teaching approach teachers most often use in their science classes

Two teaching approaches are suggested in the curriculum guide — guided inquiry-discovery and constructivist. 12 teachers state that they use the former approach and two the latter approach. This is consistent with teachers' opinions on the role of practical activities in helping pupils learn science. For teachers, enquiry means pupils answering prepared questions and doing tasks from worksheets or exercise sheets:

*'I usually use guided inquiry and experiment and I use questions for the inquiry. So if I use the experiment method in an inquiry manner, pupils will get a task card containing the instructions. Then I give a brief explanation of how to do the experiment. Then I distribute*



*the apparatus and materials, and pupils will proceed. I will go to every group to observe their work and if they are wrong I will correct them. This is if there are sufficient apparatuses. If there is not enough, I will do a demonstration and call up group by group. If the lessons do not involve experiment, I will use a question-answer approach or group discussion. That is my most frequently use strategy.' (AA)*

This typical response illustrates the emphasis that the teacher gives to inquiry — the pupils follow the instruction card and the given explanation of how to carry out the experiment or discussion. The ‘inquiry’ for teachers consists of the questions posed in the experiment or discussion to be answered by the pupils. However, Atlay and Edwards (1993) point out:

*‘ Simple involvement in “learning as inquiry” activities is not sufficient in itself for students to come to an appreciation of scientific inquiry. They may also need to be involved in an explicit examination of the processes through which scientists create knowledge.’ (p.84)*

The implication is that teachers need to redefine their understanding of the term ‘inquiry’ as discussed in the science education literature. The evidence shows that ‘science as inquiry’ is given first priority, but the ways teachers implement this contradicts the meanings given by the science education literature (See, for example Lucas cited in Atlay and Edwards, 1993).

(b) The roles teachers most often play in their class

12 respondents state that they act as guides in their classrooms. Ten see themselves as information-givers, five consider themselves to be facilitators, three are class controllers, two each are motivators and class managers, one is an expert and one is a demonstrator.

The evidence thus suggests that teachers see themselves predominantly as guides for their pupils. Teaching strategies inevitably reflect this emphasis. Teachers believe that pupils will not be able to carry out activities without teacher guidance. This preconception greatly influences teachers’ science pedagogy, as shown in answers to

other interview questions. Schilling (1993) points out that ‘To provide too much direction and too many solutions and answers can destroy children’s motivation. So too does the frustration of perceived failures, which children can experience when they are unclear how to begin an investigation, how to improvise a piece of equipment or what to record (p.146)’. This implies that the guidance teachers give to pupils must be carefully considered. The importance teachers attach to their roles as guides (12 teachers) and information-givers (10 teachers) conflicts in some ways with their statements that it is important for pupils to learn science through practical activity. They stress that practical activity will help pupils understand science concepts but in practice it is not an investigative type of activity, even though teachers attempt to apply pupil-centred experiential learning and give importance to pupils’ engagement in practical activity and discovery. It seems that pupils’ grasp of important science concepts is not based on conceptual understanding but is transmitted by teachers through their role as information-givers.

(c) The extent to which teachers or pupils control learning in the science class

In order to seek teachers opinions in the controls of learning in science class, teachers are asked to form an estimation of the controls they have on pupils in science lessons in terms of percentages.

Table 5.11 indicates that teachers’ control of science lessons is influenced by two factors: the children’s ability and the teaching strategies used, although only two respondents emphasise the latter. MA states that, even though he includes experiments (practical activity), it is the teacher (70% - teacher control learning in experiments and 90%- teacher control learning in questioning-answers approach) that controls learning. In fact, it is the same in all the classes he teaches despite



pupils’ ability. It is different in the case of ZA. She claims that she controls the learning 100% of the time during experimental work (practical activity) but she only controls the class 10% of the time if pupils are engaged in group discussion. Both teachers maintain tight control over the prepared activity given to the pupils.

Respondent	Good class		Weak class		Average class	
	Teacher	Pupil	Teacher	Pupil	Teacher	Pupil
AA	60%	40%	Overall			
BA	30%	70%	80%	20%	50%	50%
JZ	70%	30%	80%	20%	As in good class	
MA (Depends on strategy)	70%	30%experiment.	90%	10%	As in good class	
	90%	10% questions.				
MY	60%	40%	Overall			
NB	30%	70%	Overall			
NH	30%	70%	Overall			
NU	20%	80%	70%	30%	50%	50%
RU	50%	50%	100%	-	As in good class	
SH	60%	40%	80%	20%	As in good class	
SO	40%	60%	60%	40%	As in good class	
SS	60%	40%	90%	10%	As in good class	
ZA (Depends on strategy)	10%	90% discussion.	Overall			
	100% experiment.					
DZ	20%	80%	80%	20%	As in good class	

Table 5.11 Teacher control in science lessons

This evidence is confirmed by data from the other respondents. Five of them show that their control of pupils’ learning in science is similar despite pupils’ ability. Six respondents state that they allow pupils control over their own learning. But most of them agree that this only applies to high-ability pupils. When it comes to weak pupils, control is in the hands of the teacher.

Thus, the evidence shows that most teachers control the learning of science, thus reflecting their roles as guides and information-givers. Hence, teachers feel that they, rather than their pupils, must have authority in controlling science learning, and in the weaker classes the control is absolute. Those who state that they give more control to their pupils for their own learning were not seen to do so in the classroom observations.

### 5.3.3.1 Teachers' views on constructivist teaching/ learning approaches

Most respondents (ten out of 14) agree that the constructivist approach is only suitable for good classes (pupils of high-ability). One respondent states that it is applicable but not practical due to constraints of time, apparatus and teacher preparation. Another states that he does not understand the constructivist approach even though he has attended the 14-week in-service distance learning course on the primary science curriculum. Two respondents state that the approach is not applicable at all for their pupils. The majority, who agree on its suitability for good classes, think that high-ability pupils are able to put forward their ideas. However, even then, they only use some elements of the constructivist approach:

*'I only use some elements of the approach. I seldom use it because I can't finish it. I seldom do the reflection part but I do use the generating ideas phase. So I do use it, but not totally because of time constraints and too much pupil activity. However, I only use it for good and average classes. The weak class - if I want to wait for them to generate ideas I will not get them before the lesson ends.'* (AA)

Two other respondents observed:

*'From what I see, it is good. Teachers probe pupils' knowledge, and give pupils the opportunity to apply it. Sometimes we can't just guide them. Looking at my pupils' prior knowledge and background, they just cannot. I just guide them to give ideas; they cannot do it. Sometimes I only give questions, but they cannot answer. So it is not applicable totally due to their background.'* (RU)

*'For Year 4 pupils, first I cannot use this approach because of the pupils' level. I am teaching Year 4, I feel my pupils will not be able to learn if I use constructivism. I feel at this initial stage, they have only started to learn science and there is a lot they don't know and need a lot of guidance from teachers.'* (SS)

This evidence again shows that teachers have preconceived ideas that pupils do not know anything, have no prior knowledge, and have an inadequate background. Teachers do not think that children have accumulated knowledge and their own ideas. This lack of science pedagogical knowledge of how children learn results in teachers saying that the approach is good, but they also produce reasons for not using



it. All 13 teachers (except for one who does not understand it) agree that the approach is good. The implication is that they do not really know how to practice it or they have little knowledge of it, and, since it is only briefly described in the curriculum guide, they are reluctant to admit it. In this context, Hand and Treagust (1994) found that an in-service programme was able to encourage teachers to implement and reflect on constructivist approaches. There was a distinct change in the way teachers viewed classrooms, and this changes was related to issues such as the separation of control of learning from management, the valuing of student knowledge, and the need to involve students within the learning process. Therefore, an immediate step has to be made to develop an in-service programme to help the Malaysian primary science teachers understand the effectiveness of teaching science from a constructivist perspective so that they can use this method in their classrooms.

**(a) Teachers' opinions on taking account of children's ideas in teaching science**

Thirteen out of the 14 teachers state that they give full consideration to children's ideas when teaching science. However, to them a child's idea is an answer given to a teacher's question, usually to find out how much pupils know about the topic. This idea is not actually used in the lesson, as teachers have already prepared their lesson plans and they will continue with whatever activity they have prepared. Teachers relate pupils' ideas to a brainstorming concept:

*' It's like brainstorming All answers pupils give I will accept, then divide them. Then I will list them down. Then I discuss in the question/answer session why some answers are acceptable and some answers are not. So pupils will know. I don't kill their interest, meaning that if I have the question sessions pupils will feel comfortable to give ideas when I do the discussion. Even from the weak class I have to accept their ideas because if I say it is wrong it will influence the others and they will keep quiet and not speak. ' (MA)*

Even though teachers claim to give full consideration to pupils' ideas, they are actually referring to pupils' responses towards their questions during the lesson:

*'In teaching it depends on topics. What I usually do is brainstorming. In a lesson during an induction set, I will do brainstorming and ask pupils to give ideas. I give questions, pupils will give answers to the questions or what they think the answer is. Every pupil will give his or her ideas. I do not mind if the answer is correct or wrong. Then I will take the pupils' ideas to continue the lesson. So if I don't brainstorm, I will do it through questioning and pupils who have experience of what I asked would give the answer.'* (DZ)

Only one respondent admits that she does not give consideration to pupils' ideas because the time allowed for lessons is too short. She also states that sometimes she feels that the ideas pupils give are nonsense, as pupils don't really know anything, especially the Year 4 pupils.

This evidence confirms the data on the teaching strategies that teachers use. In general, teachers prefer practical activity, but this is still teacher-directed learning. As mentioned earlier, teachers need help in understanding how to value children's ideas as a starting point in a lesson and to use these ideas to develop the lesson further.

(b) Teachers' opinions on recognising the importance of pupils' active participation in learning in their class

11 respondents state that they give importance to pupils' active participation in learning, but their comments on this subject vary:

- Active participation decreases discipline problems.
- Active participation makes lessons lively and interesting.
- Active participation helps teachers gain more information from pupils.
- Active participation reflects effective activities.
- Active participation reflects good teaching.
- Encourages pupils not involved by directing more questions to them.
- Gives group work to ensure active participation.
- Outdoor activity for weak pupils will ensure active participation.
- Participation occurs if the group is small.
- Pupils work in a group but note down results as individuals.
- Trains pupils to become confident and put forward their ideas.



Three teachers claim that they cannot give importance to active participation due to pupils' low- ability and the large size of the group. Teachers also state that there is not enough equipment.

The evidence suggests that most teachers perceive that active participation in science learning is mainly physical in nature. When pupils are engaged in any activity, they are seen to be actively participating in learning. The reasons given reflect teachers' general pedagogical knowledge in ensuring pupils actively participate in the activities provided. Only one respondent relates active participation to pupils' scientific attitude — a confidence in putting forward ideas. This shows that these teachers believe that pupils must be actively engaged in a science lesson. . However, no respondents are critical of active learning, when pupils are engaged in making the learning meaningful, i.e. in understanding the link between real phenomena and the activities in the classroom. This is confirmed by the data below on teachers' opinions about 'pupils as active learners'.

(c) Teachers' opinions on the idea that 'pupils are active learners'.

Table 5.12 is a summary of teachers' responses to the activities related to pupils as 'active learners'. Teachers generally take the view that when pupils are engaged in a strategy, they are active learners. Teachers are unaware that the term might mean pupils having questions on the activities provided and debating their findings or conclusions. Teachers feel that pupils can be problem-solvers when guided by the teachers, but this is only applicable to high-ability pupils. This supports the beliefs that teachers have on guided-inquiry/discovery, which involves tight control of the teaching of science.

Respondent	Activities	Pupils Roles		
		Problem solver	Discoverer	Experimenter
AA	Group-work, discussion, experiment	√ (not all pupils)	X	X
BA	Contribution of ideas, group-work	√ (high-ability pupils)	X	X
JZ	Experiment	√ (sometimes)	X	X
MA	Experiment, project	X (need to refer to teachers)	X	X
NB	Observation, experiment, project, simulation, quiz	√	X	X
NH	Practical activity, question-answer session	√	√ (depends on activity)	X
NU	Discussion, experiment	√ (some)	√	X
RU	Discussion, experiment	√	X	X
SO	Experiment, discussion	√ (with teacher's guidance)	√ (with teacher's guidance)	X
SS	Experiment	√	√ (few pupils)	√ (few pupils)
SH	Experiment	√	X	X
ZA	Experiment, discussion	√	X	X
DZ	Practical activity	√	√ (few pupils)	√ (few pupils)
MY	Experiment	√	X	X

Table 5.12 Teachers’ opinions on the idea of ‘pupils as active learners’

A majority of respondents feel that pupils are not able to be experimenters. This results from their teaching styles — teaching is the following of instructions with teachers’ explanations on the procedures to be carried out. Therefore, they believe that it is not possible for pupils to be experimenters. The implication is that what teachers understand as ‘guidance’ is actually instructions. This confusion has distorted teachers’ understanding of the intended curriculum. Teachers’ misjudgement of the nature of ‘guided inquiry’ has resulted in a traditional teaching approach to the primary school science curriculum i.e. with an emphasis verifying facts, proving theories, and following recipe methods of practical work.

(d) Teachers’ comments on the approach that they use in their science classes

Table 5.13 summarises teachers’ responses on the approaches they use in science teaching. Ten respondents use the guided inquiry-discovery method, as suggested by the curriculum guide, but stress that it is generally only applicable for good and average pupils. Two use a constructivist approach but only with good classes. One states that she only uses the suggested approach for Year 5, since it is not suitable for



other years due to the pressure of exams requirements. Teachers sometimes put their personal beliefs and priorities first before considering the intentions of the curriculum. Another respondent believes in combining approaches to make learning science fun. Again, this reflects his personal belief.

Approach	Reasons	Number of respondents
Guided inquiry-discovery approach	Experiment, discussion ,searching, activities, suitable for A and B class not C	10
Constructivism	Suitable for good class, not applicable for weak class	2
Approach depends on situation	Year 6-cannot apply any approach-rush to finish syllabus for exam Year 5- able to use guided inquiry approach Year 4- syllabus too wide and pupils are new to science; approach is not applicable	1
Mixture of approaches	So that pupil will not get bored and stress, make learning fun with riddles and etc.	1

Table 5.13 Teachers’ opinions on approaches used in science lessons

5.3.3.2 Teachers’ knowledge of learners’ characteristics in science learning

(a) Developing pupils’ scientific skills

Table 5.14 summarises teachers’ responses on developing pupils’ science process skills. Six processes are identified for developing these skills. A majority claim they develop pupils’ science process skills by integrating them into the activities provided.

Respondent	Process					
	Using questions on the SPS in every lesson	Introduce the SPS in a special lesson first	Integrate SPS into the activity	Gradual increase of SPS level for pupils	Inform pupils of the SPS that will be used before the lesson	Inform pupils of the SPS that was used after the lesson
AA			√	√		√
BA						
JZ			√			
MA	√				√	
MY			√	√		
NB			√	√		
NH	√					
NU			√			
RU		√				
SH	√		√			
SO		√		√		
SS	√				√	
ZA		√			√	
DZ		√	√			
TOTAL	4	4	7	4	3	1

Table 5.14 Teachers’ techniques for developing pupils’ science process skills (SPS) in science lessons

This variation in developing skills is indicative of the importance teachers' attach to this objective because of its inclusion in the national exam. It is the most difficult and challenging factor for teachers in teaching science in primary school. However, the methods teachers use in promoting pupils' development of science process skills are questionable and somewhat unconvincing.

Harlen (2000) suggests that opportunities for process skill development have to be provided frequently, if not continuously. She further stresses that it is of no use if certain process skills are allocated in one or two sessions and then forgotten. In her view, there are certain things the teacher has to do to enable children to use and develop all the process skills. These include:

- providing an opportunity for children to encounter materials and phenomena to explore at first hand
- arranging for discussion in small groups and in the whole class about procedures that are planned or have been used, so as to identify ways in which they might be improved
- providing access to alternative procedures through discussion, books, etc.
- setting challenging tasks whilst providing scaffolding so that children experience operating at a more advanced level
- teaching the techniques needed for advanced skills, including the use of equipment, measuring instruments and conventional symbols
- encouraging children through comment and questioning to check that their ideas are consistent with the available evidence
- encouraging critical reflection on how they have learned and how this can be applied in future learning
- using questioning to encourage the use of process skills, for example:
  - What would you like to know about.....?
  - Why do you think x is growing better than y.....?
  - What do you think will happen if.....?
  - What will you do to find out.....?
  - What differences do you notice.....?
  - Have you found any connection.....?
  - What is the best way to show what you found? (p.189)



The techniques respondents use to develop pupils' science process skills imply that the respondents have oversimplified their approaches to developing these skills. Even though a majority claims to integrate the science process skills into practical activity, this is mostly done through questions on the worksheets. A few state that it is by using questions on science process skills in every lesson, but this is also through the worksheets. The point made by Harlen (2000), above, suggests that the roles teachers need to apply in developing pupils' science process skills include:

- providing materials, time and physical arrangement for children to study and interact with things from the environment;
- designing tasks that encourage discussion among small groups of children; discussing with children as individuals and in small groups;
- organising whole-class discussions;
- teaching the techniques of using equipment and the conventions of using graphs, tables, charts and symbols;
- providing books, displays, visits, visitors and access to other sources of information (p.191)

It seems that teachers are aware that these skills need to be integrated in the science activities, but the lack of science pedagogical knowledge means that the method of developing pupils' science skills is oversimplified. Teachers need to be enlightened on their strategies and roles in facilitating pupils' process skill development, and need to appreciate that questions given in worksheets should be supplemented by other but in more explicit techniques such as those suggested by Harlen (2000).

#### **(b) Developing pupils' scientific attitudes**

Table 5.15 summarises teachers' responses on developing pupils' scientific attitudes. The curriculum guide lists 12 scientific attitudes and noble values to be instilled in primary pupils. Module 4 — 'Scientific Attitudes and Noble Values' as developed by CDC (1994d) outlines each of these scientific attitudes and noble values by giving

each of them indication keys for the purpose of evaluation. The module was prepared with a video to enhance teachers’ understanding.

Table 5.15 shows that six out of 12 scientific attitudes and noble values outlined by the curriculum guide were mentioned during the interviews. Among these, four are scientific attitudes (1- 4) and two (5 and 6) are noble values.

Respondent	Attitudes					
	1	2	3	4	5	6
AA		√				
BA		√	√	√		
JZ	√	√		√		
MA	√					√
MY						
NB		√			√	
NH		√				
NU						
RU		√				
SO	√	√				
SH		√				
SS	√			√		
ZA		√				
DZ	√			√		
TOTAL	5	10	1	4	1	1

Table 5.15 Teachers’ opinions on instilling scientific attitudes

1.interest and curiosity in the environment, 2. honest and accurate in verifying data  
3. flexible and open–minded, 4. systematic and confident, 5. responsible for self safety and others including the environment, 6.grateful for God’s given things

The fact that most teachers refer to scientific attitudes related to recording and verifying data is reflected in their teaching strategies, which mostly use practical activities. The implication is that when more emphasis is put on honesty and accuracy in recording and verifying data, it might diminish the role of other scientific attitudes such as ‘flexible and open-minded’, ‘systematic and confident’, and ‘perseverance in handling things’.



Harlen (1993b) lists five scientific attitudes that are of particular relevance to science: curiosity, respect for evidence, flexibility, critical reflection, and sensitivity to living things and the environment.

This shows some similarity with the scientific attitudes to be instilled in Malaysian primary pupils, especially flexibility and open-mindedness. Harlen (ibid.) further explains that in terms of evidence, pupils need to show open-mindedness in changing their original views, perseverance in obtaining really convincing evidence, and willingness to consider conflicting evidence. She further explains that in terms of 'flexibility' children need to be willing to reconsider ideas and recognise that ideas are tentative. Fostering these attitudes helps children to feel that they can participate in developing ideas rather than receiving 'the right ideas' from others.

This implies that instilling scientific attitudes is an important area in science teaching. Developing these attitudes early means adults will be more responsible in their actions. However, the interviewees gave somewhat unconvincing responses on the importance of scientific attitudes. This is also reflected in their teaching. All the respondents' express similar beliefs about the development of pupils' scientific attitudes. They all agree that these scientific attitudes are integrated into the lesson through the activities, i.e. they are covered indirectly. The implication is that these attitudes are developed automatically and there is no need to teach them specifically. The development of scientific attitudes is not given much emphasis by primary school teachers. Most agreed that they only mention it in passing without stressing it:

*'It's not often, sometimes I don't remember; when I remember I mention it.'* (ZA)

*'Usually it is not given emphasis, I just mention it indirectly, maybe during the exercises.'* (SH)

*'Sometimes there are so many things I want to remember that I forget to mention it even though I know it is important for children.'* (AA)

These responses indicate that the suggestion by CDC in Module 4 that teachers need to evaluate pupils’ scientific attitudes is not actually implemented. Even though the Module states that these attitudes can be instilled indirectly in planned and unplanned situations, by suggesting that these attitudes can be evaluated using a prepared checklist it encourages teachers to regard this as an important issue in science teaching. Therefore a monitoring system needs to be developed in order to determine whether children actually foster these important scientific attitudes.

**5.4 Teachers’ Views and Opinions on Barriers to Implementing the Primary Science Curriculum**

***5.4.1 Teachers’ initial perceptions of barriers to implementing the primary science curriculum***

Barriers	N=14
Lack of apparatus, equipment and material	9
Pupils- ability, large numbers, attitude	7
Time allocation for science is too short	4
Resources	4
Teacher own inadequacy	3
Support	1

Table 5.16 Teachers’ opinions on the barriers to implementation of the primary science curriculum

In the views of the respondents on the barriers to implementing the curriculum, six factors emerge. The main one is lack of apparatus, equipment and material for science teaching. Contributing to this are factors such as ‘too many pupils in a class’, ‘apparatus does not come on time after being ordered’, ‘equipment and material provided are of low quality’, ‘lack of pupils reference books and textbooks which do not provide enough content for children’. The second major barrier is presented by pupil factors: — their abilities, their attitudes, their involvement in the lesson, and classes that are too large. Resources are also a problem. This includes the physical



structure of the science room — too small to accommodate large numbers of pupils; chairs and tables are not suitable for group work; not enough science rooms. Time allocation is also considered a barrier; teachers find that the time allocated is not enough for them to prepare and teach primary science. Three see themselves as a barrier to implementing the curriculum, admitting that they lack the necessary knowledge. Only one respondent feels that lack of administrative support is a factor. When teachers were further probed on teaching resources in their respective schools, 11 out of 14 respondents claimed to have enough resources to teach science. These include overhead projectors, commercial transparencies, charts and science reference books. Two teachers claim there are insufficient resources, but they were referring to lack of apparatus and equipment. Another felt that her school lacked science reference books for teachers as well as pupils. She claims that those provided for pupils in the library are at too high a level and, furthermore, they do not match the science topics.

The evidence indicates that the most serious barrier teachers face in implementing the curriculum is lack of apparatus, material and equipment, with pupils factors also contributing. This is reflected in the teaching strategies which teachers most frequently use — practical activities. Therefore, teachers have difficulty in using the limited equipment with large numbers of pupils. The Malaysian Ministry of Education, especially the Supply, Privatisation and Development Division, should give this problem serious consideration. Classroom observations also confirmed that one set of apparatus was shared among six/seven pupils in a group, resulting in one or two pupils monopolising the activity. If this problem is not overcome, the quality of pupils' science learning is likely to remain lower than it should be.

**5.4.2 Teachers’ perceptions of the science room as an aid to science teaching**

There are a greater number of negative comments about the suitability of the science room than there are positive comments (Table 5.17). Teachers still need more aids and better facilities for teaching science, and such support should always be available to help them implement the curriculum.

In practice, most schools have to share one science room between 10-15 classes, resulting in limited access to the room. It is impossible for every science lesson to be carried out in the science room. When it is used, the science room generally provides a suitable learning environment for pupils, enabling them to get used to the apparatus and the systematic ways of working or doing science.

Improvement here will help science lessons to be implemented as intended. Most schools, except newly built ones, have a science room modified from a classroom, reading room or any other available room in the school. Extra equipment and storage facilities reduce the working space. This was observed in nine schools, where the children were cramped in the science room with hardly any space for movement. Only one school had a spacious, purpose-built science room.

Helped/not helped	Reasons	N=
Helped	Easy to do group work with mixed-ability pupils in the science room	14
	Easy access to material and equipment	4
	Suitable as a science learning environment	3
	Science room suitable for safety reasons	1
Did not helped	Limited usage of science room due to many classes sharing one science room	7
	Size of science room too small for large numbers of pupils	5
	Water supply problems in the science room	3
	Physical structure of science room-tables, chairs	3
	Maintenance	2
	(the arrangement of equipment and apparatus and ‘after teacher’ usage)	2
	Difficult to control class	2
	Science classroom situation e.g. next to music room	1
	Blackout curtains not provided	1

Table 5.17 Teachers’ responses on the support they received by having a science room



Teachers' perceptions of their science rooms in their schools confirm their arguments that this factor is a barrier to implementing the curriculum. This problem should be addressed immediately.

#### ***5.4.3 Teachers' perceptions of the support they received in implementing the curriculum***

13 respondents had the support of the headteacher in implementing the curriculum. This support included the provision of resources, science equipment and materials within the budget specified by the ministry. Two respondents from the same school reported that they received moral support for their teaching strategies. Their headteacher is also a key science member of the District Education Office. The one respondent who did not feel that the headteacher supported him replied that all matters were discussed only with the head of science.

12 respondents also mentioned colleagues' support. This included discussion on teaching strategies that were difficult for them to carry out in their classroom; support in terms of preparation of materials and apparatus and for science club activities. Only two respondents felt that their colleagues did not support them in implementing the curriculum:

*'No support, each of us have our own responsibilities. Only when there is a problem do we discuss it.'* (ZA)

The district education officers also support teachers in implementing the curriculum. They provide on-going courses for science teachers, which include briefings on teaching strategies, evaluation, and question and exam formats. They also visit schools for regular inspections. However, one respondent does not feel that the

district education officers support her in implementing the curriculum; they only dealt with the schools' administrator.

Ten respondents state that the teacher activity centre does not support them in implementing the curriculum except by providing facilities for courses. The four who state that the teacher activity centre does support them mention courses on using the computer in teaching science and producing teaching aids for science.

#### ***5.4.4 Teachers' opinions on the organisation of pupils in science classes***

Respondents give four reasons — topic, teaching strategy, materials and time available — for using whole class, small group or individual teaching methods.

Individual teaching is only use with weaker pupils or when particular problems arise:

*'Usually I will use a combination of organisation, depending on topics. Whether discussion is suitable for whole class teaching or pair teaching depends on the topics. For example, the earth and the universe topic: sometimes pupils have no knowledge on the topic, so I will use whole class teaching. Like the 'living world': pupils have knowledge of it, so group work or pair work is for such easy topics. If I let them work individually sometimes it takes half an hour and they still don't know. So pair teaching is easier. Individual teaching is used when pupils' progress is slow; then I will call them up when there is a problem.'* (NU)

*'I use all methods, but individual teaching is for weak classes. If I use discussion or question-answer session, it will be whole class teaching. When I do activities it will be small group teaching. Individual teaching is when pupils answer questions and for the very weak pupils who cannot keep up with their friends. So frequently there is whole class teaching and small group teaching.'* (RU)

This shows that these teachers are aware that different ways of organising both the class and classroom are appropriate for different times and purposes. However, for grouping to contribute to teaching and learning it has to be more than a convenient seating arrangement. As Bradley (1996) observes:

*'Learning in groups is a more complex and demanding activity than whole class learning and cannot function effectively in a classroom unless the children are able to respect their own and each other's learning and to use listening and negotiating skills.'* (p.115)



The decisions teachers make on the best organisation will depend on the particular activities and the size and composition of groups (Harlen 1996). Grouping children for learning science should reflect teaching science as a way of doing, seeing and thinking, based on children's experiences and the concepts that they hold (Bradley 1996). Unfortunately, this is not in the Malaysian primary science teachers' framework, and children's grouping is therefore essentially based on physical requirement such as materials, time and teaching strategies. Even though teachers mention group work, small group discussions, and whole class and individual work, this does not take account of the need for science activities to match the requirements of the children. It was observed that grouping children in science learning was intended to ensure that all pupils carried out the same work regardless of their needs and ideas.

This shows that Malaysian primary science teachers need to understand that grouping children for effective science learning is not only for physical reasons, but is also related to how children learn best in a group. Bradley (1996) suggests that when teachers plan to group pupils for science learning, they need to ascertain the range of ideas held by the class. Then they can make decisions about which science concepts need to be taught next and what activities are most appropriate.

## **5.5 Teachers' Personal Views on the Science Curriculum**

### ***5.5.1 Teachers' opinions on the primary science curriculum***

All teachers interviewed agree with the implementation of the new primary science curriculum. Four categories of response can be identified:

- It is a better curriculum than 'Man and Environment' (Ten respondents)  
(The course before science was introduced as a separate subject)
- It is of personal interest (one respondent)

- It prepares pupils for future needs.(two respondents)
- It prepares pupils for secondary science (one respondent)

The references to 'Man and Environment' include comments that it is a combination of several subjects including science. Thus, very little science is taught and pupils have difficulty with science when they go to secondary schools. So for many of the respondents, the present science curriculum gives pupils knowledge and skills in science that are absent from 'Man and Environment'. The teaching community accepts the curriculum innovation willingly as a great improvement:

*'It should have been done earlier. Previously the 'Man and Environment' mixed everything so pupils were not clear about the things they learned and many things were left out. So when they learn science it is good. The change is good. The old curriculum should have been continued and we should not have had 'Man and Environment'. When 'Man and Environment' mixed everything, pupils knew very little science that was transmitted to them directly.'* (NB)

### **5.5.2 Teachers' comparisons of the teaching of science in the old and new curriculum**

Nine respondents (three who have not taught the old curriculum did not respond) find that teaching science is better than in the previous 'Man and Environment (MAE)' subject. However two respondents state that teaching MAE was as good as the present science curriculum. Comments on the two curricula include:

- MAE is difficult to teach and a burden for teachers
- MAE is easier to teach than science
- MAE only transmits content to pupils, whereas science emphasises thinking skills and scientific skills
- Science in MAE was not balanced
- Science is easier to teach
- Teaching science is challenging
- Teaching science is systematic
- There is a continuation in science compared to MAE

There are pros and cons for both curricula. Some respondents state that it was easy to teach MAE since they only had to transmit knowledge to pupils without having to



develop any skills. Those who claim that MAE was difficult say that this was due to subjects being combined so they had to know them all in order to teach MAE. One respondent also feels that the science in MAE was not balanced because the emphasis was on living things, with nothing on physical science or materials. Those who claim it is easier to teach science say it is because it is now a focused subject and so the teacher can concentrate on one subject. One states that it is systematic and it has ‘discipline’. Another feels that science teaching is easier because there is continuity and progression, making it easier to plan.

#### *5.5.2.1 The curriculum teachers feel most comfortable with*

Eight respondents out of 11 are most comfortable with the science curriculum, and three feel most comfortable with the MAE curriculum. In analysing teachers’ responses, the main reasons for feeling comfortable are:

- Science has focus
- Science has continuity
- Science has specific approaches and strategies

Most respondents who claim that science has a focus imply that there is no need to refer to other subjects. Furthermore, one respondent feels that the syllabus is systematic and that it is easy to determine pupils’ ability since the subject is now focused. That science has specific approaches and strategies makes it easier to teach the science curriculum. The respondents also stress that they have guidelines on teaching the science process skills. Another respondent who says that science has continuity means that she is able to teach the skills and the content gradually to the required level.

The three teachers who were most comfortable with the MAE gave the following reasons:

- It was not an exam subject and there was no need to teach science process skills
  - The topics covered in MAE were few and not onerous
  - It focused on biology, which is what I was doing in my distance learning.
- These reasons are very much personal ones, which do not interfere with the teachers' 'comfort zone'.

## 5.6 Teachers' Ideology on Primary Science Curriculum

Here we analyse teachers' attitudes, values and beliefs towards the primary science curriculum.

### 5.6.1 Teachers' attitudes towards the primary science curriculum

In looking at respondents' patterns of attitude (Appendix 5) towards the primary science curriculum, three common strands emerge:

- As a preparation for the children in secondary school
- Earlier implementation
- For the benefit of the children

Out of 14 respondents, seven state that the primary science curriculum benefits children in several ways. Some of the reasons relate to children being able to develop their interests and intellectual capability:

*'I feel it is good for the primary school children because it emphasises skills, increases interest and develops talent.'* (NB)

*'Pupils are able to explore their environment and they enjoy learning new things.'* (SO)

*'I hope to develop pupils' ability in making decisions, and conclusions, and generating ideas.'* (SS)

These respondents feel positively towards the primary science curriculum, implying that in implementing the curriculum they will have pupils in mind when approaching the pedagogy of science. They will be approaching their teaching in a pupil-centred way.



Four respondents feel that the primary science curriculum prepares pupils for secondary school science.

*'It will be easier for the pupils when they go to secondary school since they have a basic science, so it will be easier for the secondary school teachers.'* (RU)

The implication is that teachers' preconception of primary school science is that it gives a basic knowledge of science to the pupils. This is mainly a matter of content knowledge.

*'I can see that there is a bridge of knowledge from Year 6 to Form 1.'* (BA).

Even though teachers feel positively towards the primary science curriculum, and will seek to implement the curriculum, they give more emphasis to content knowledge and this is bound to influence the way they teach.

Two respondents feel that the primary science curriculum should be implemented earlier.. Out of 14 respondents, only one has a negative attitude:

*'The standard is too high. I remember that the last time I learnt science it was simple. This one is more detailed and the Form 1 science of the secondary school is also at this level. I feel it should be introduced, but the scope must be reduced.'* (JZ)

This teacher agrees with the curriculum innovation but disagrees with the syllabus needs. This is reflected in her argument on the problems she faces in teaching primary science. It is not suitable for her pupils who, she says, are from rural areas and thus lack prior knowledge. Her understanding of primary science is that it is only effective with pupils with prior knowledge. She explains further:

*'It is difficult for me to include thinking skills because pupils lack prior knowledge, so the teacher will have to speak all the time and pupils can't speak because they don't have knowledge and so have no thinking skills.'* (JZ)

She implies that not all the intended curriculum can be implemented. Her argument is based on pupils' abilities and environment. This, in turn, suggests that teachers'

pedagogical knowledge is an important component of their attitudes towards innovation. Teachers' knowledge on learners' abilities is important in implementing the curriculum. Furthermore, teachers' own competency with the curriculum is also a factor influencing teacher attitudes towards the curriculum:

*'The exam questions include thinking skills. If it was given to me I would also find it difficult. In the last national exam question, I myself found it difficult not like last time. Now the questions are of a high standard, including the thinking skills.'* (JZ)

The implication is that teachers feel a sense of inadequacy and incompetence with the curriculum, and this is bound to effect its implementation.

The pattern is that most respondents have positive attitudes towards the primary science curriculum. They agree with the innovation and are happy to accept the new curriculum. This shows that the innovators have been successful in persuading the implementers. However, teachers' agreement with the innovation does not mean that they understand the innovator's conceptual ideas as documented in the Teachers' Curriculum Guide and Teachers' Guidebook.

In spite of their positive attitudes, respondents express some disagreement with certain procedural implementations. For example, they are concerned with the implementation of the new curriculum in Year 4. They are aware of the problems pupils face when suddenly exposed to science as a new subject. One respondent argues that:

*'When it is implemented in Year 4, it is difficult for the pupils to understand because only in this year are they exposed to science. I feel it is better if it is introduced from Year 1 or at least it is done as science across the curriculum with other subjects.'* (DZ)

They feel that there should be some kind of introduction to science in Phase I (Years 1, 2 and 3) for the pupils' benefit before they enter Year 4 for formal science learning. Teachers perceive that pupils are experiencing 'subject shock' and if it is



introduced earlier through cross- curriculum approaches, it will be a more gradual change for pupils and will help the implementation of the curriculum.

This argument can be related to some of the concerns teachers have about pupils with respect to the new curriculum. They have a strong positive belief in the advantages of learning science, e.g. pupils' ability to become independent and develop thinking skills, but it is believed that these are gained only by the good pupils. On the other hand, teachers' negative beliefs about the primary science curriculum include the problem of content overload, when pupils have to sit for the final examination in Year 6, and the difficulties with science process skills among the pupils, especially the weaker ones.

Among the respondents, only one male teacher is very disappointed by the way the curriculum was implemented:

*'It was done in an ad-hoc manner. The Ministry made the plans but the preparation of the teachers was done in two weeks. All was covered in two weeks. It should have started in 1996, but it was done earlier, in 1995. Most schools were unhappy. There was not enough equipment and the equipment provided was of low quality'. He added: 'there was always a last minute directive, like the science process skills. When I attended a course on the first national exam (UPSR) for science, we were told not to teach the science process skills to the children, but about two to three months before the exam teachers were asked to teach the science process skills in that short period of time. It was stressful for the pupils.'* (MA)

This teacher feels that any curriculum innovation could have been done in a better way, with good planning and preparation, so that the curriculum could be implemented effectively. This suggests that when a centralised curriculum is to be adopted by schools, there are many obstacles to be faced. These can be seen in this teacher's responses towards the primary science curriculum's method of implementation. In general, all teachers in Malaysia agree with the innovation as it is a directive from the central government, and they are considered to be civil servants in the government sector. Hence, they abide by central legislative directives. Thus

most of them agree with the innovation. However, the disagreements and the feelings of dissatisfaction must also be taken into consideration. Generally, teachers' attitudes towards teaching the primary science curriculum are positive. Seven respondents show very positive attitudes towards teaching the subjects. Most of them stated their great interest and enjoyment in the subject. The seven teachers with mixed feelings stress that there were initial difficulties in teaching the subject but later they became used to it. Some mention the challenge they feel in teaching the subject. However, some important issues emerge: First, the exam-oriented culture teachers bring with them is of great significance:

*'I work hard to make them understand, but it's enjoyable because I can see the output last year in their national exam result [UPSR].'* (NU)

*'So pupils who cannot understand a concept will learn it by rote. This is not good because questions will now test pupils' thinking ability'* (NH)

*'For science, I have satisfaction because it is tested in the national exam [UPSR], so science is given more importance.'* (SH)

Thus, science as a core subject in the primary curriculum and one that is tested in national examinations will ensure the implementation of the curriculum. This gives rise to another issue: whether the teachers teach the primary science curriculum on educational grounds or do so mainly to meet the exam requirements. As the above respondents teach Year 6 pupils who will be sitting for the exam, their main concern is with the exam results.

Secondly, teachers are worried about pupils' development of science concepts:

*'These children understand but sometimes they cannot see the concepts. At the moment of discussion they seem able to understand but when asked later they do not remember.'* (NH)

*'When science was introduced, it became a "solid" subject and I had to take time to make pupils understand the concepts. This is difficult'* – (DZ)



These concerns reflect the exam-oriented culture in Malaysia. The implication is that teachers find it difficult to transmit the science concepts. This evidence suggests that if pupils cannot understand science concepts it will be difficult for them to answer exam questions later, and that whatever reasons teachers give it will reflect on their attitudes in an exam-oriented culture. Teachers' concerns about pupils' development of science concepts should not only reflect pupils' outcomes in examinations but should also be related to the aims of learning science with understanding. This will only occur when there is a conceptual change. As Wilson (2000) observes:

*'Concepts allow us to classify and process incoming information by drawing on past experiences. Successful integration of new concepts takes place when the learner is able to categorise and store ideas in order to deal with them more efficiently. Conceptual change happens when naïve beliefs about natural and social phenomena are replaced by more sophisticated ones' (p.38)*

This implies that the respondents are not aware that difficulties in understanding concepts are due to pupils having a 'misconception' which has not been changed to the scientific view. This is influenced by the teachers' views of how children learn science and the nature of children's ideas (discussed in Section 5.3.3.1 a, b and c) — a view which is not consistent with the science education literature. Therefore, there are many aspects of teaching and learning science in the primary school that teachers need to understand if they are to achieve high-quality primary science teaching.

Surprisingly, only one respondent reflects critically on her teaching:

*'Sometimes I feel unsure of how to convey the lesson to my pupils, so it is quite difficult. I try a method and if it doesn't work I change the method' She adds: 'the scope of the subject is too wide and I am not sure how much content to give.' (NB)*

It is uncommon for Malaysian teachers to reflect on their practice. But the teacher's comment shows the need for in-service support. Her feeling of inadequacy is a good reflection since it will help her to improve her teaching. The evidence is that

teachers should be self-reflective to improve their teaching practices, and this is one of the ways teachers can begin to implement the curriculum as intended.

However, almost all the teachers' concerns are based on exams and the need for pupils to achieve good results. This is a consequence of the education system in Malaysia, which puts enormous emphasis on the exams as a criterion for evaluating good schools and good teachers. So, teachers should not be blamed if the implementation of the intended curriculum is not as intended. The imbalance between the curriculum and the exam should be discussed if the curriculum is to be implemented as intended.

The analysis of teachers' attitudes towards science in relation to other subjects shows a very positive attitude towards science compared to other subjects: nine out of 14 respondents give a positive response; three give a negative response, one is neutral and one does not respond.

The three negative respondents claim that science needs a lot more preparation to teach — preparation of knowledge, teaching aids and equipment — and thus needs more time:

*'I cannot teach science without preparation.'* (AA)

*'The difficulty is the equipment. Other subjects like Malay Language and Mathematics do not need equipment, but in science we need a lot of equipment if we want to carry out experiments.'* (NB)

The following is a more neutral reply:

*'All subjects are interrelated and the important thing is the learning skill.'* (MY)

Those who offer positive responses give three reasons why they like teaching science compared to other subjects:

- Science is based on facts. Thus, it is easy to get facts through books, references and experiment and observation;



- The variety of strategies (activities) used is not boring. It is easy for pupils to understand through these activities, and some activities are interconnected with other subjects.
- Skills in science relate to thinking skills, problem-solving and making decisions.

Most respondents like teaching the primary science curriculum and it seems that they prefer teaching science compared to other subjects. There is a positive attitude among most of the teachers to teach primary science despite any feelings of ‘uneasiness’ in implementing the curriculum in their respective schools.

### ***5.6.2 Teachers’ values in the primary science curriculum***

In analysing teachers’ values in the primary science curriculum, three questions were considered (Appendix 6). First, by looking at teachers’ opinions on how they view a good science lesson, three categories of response were identified: approaches, classroom organisation and feedback from the pupils.

There are different responses on the approaches used, and they reflect the teachers’ belief that their own teaching methods are the best way to teach science:

- Group activity (three respondents)
- Doing experiment (eight respondents)
- Inquiry approach (guided inquiry approach) ( three respondents)

The explanations respondents give when describing group activity as the best way to teach science are similar. They agree that group activity has a discussion session, then the appointment of a presenter, and then the presentation to the whole class as the final stage in reaching a conclusion.

Those who maintain that a good science lesson is based on experiment, emphasise (1) pupils’ enthusiasm, (2) science process skills, (3) and the needs for science to include experiment. They feel that doing experiments will increase pupils’ interest.

*'I always see that the strategy that provides the most interest to pupils is doing experiments. They really show enthusiasm when asked to collect the apparatus and cannot wait to start the experiment.'* (MA)

For the second subgroup (science processes skills), respondents agree that in doing experiments pupils will gain process skills which will enhance their thinking and problem solving skills:

*'experiment....when pupils have the science process skills, they will gain the thinking skills so when I ask them to analyse and classify they will be able to do it.'* (MY)

The third subgroup reflected the teachers' basic understanding of science education. By saying that science must include experiments, teachers seek to realise their values in classroom teaching.

However, these three subgroups are inter-connected. When pupils have a deep interest in science, they are able to handle the learning by themselves through hands-on activities. This helps pupils to gain the science process skills.

The third category, the inquiry teaching approach, leads to different opinions:

*'Inquiry teaching approach- pupils raise problems, carry out the activity and get the concept by themselves.'* (NB)

*'Guided inquiry approach- from pupils' experience and inquiry strategy. But I have to guide them, provide enough material and explanation. Pupils will remember easier through experience and they will understand easily. The inquiry approach — the pupils will follow the task card, then they will have experience.'* (AA)

*'Inquiry approach- we start with a set induction to probe pupils' knowledge about the topic. We want to use an inquiry strategy, we stimulate pupils until they are able to see what we really want to teach them.'* (SO)

AA and SO acknowledge the inquiry approach but actually use a guided approach. Thus, this shows that they are following the curriculum and emphasise a guided approach to inquiry. However, we need to ask: do teachers understand the meaning of 'guided' or do they understand it to mean a teacher-directed lesson. The response



given by AA implies an emphasis on teacher-directed learning. This can be seen later in the analysis of classroom observation.

One respondent commented that a good science lesson is when pupils raise the problem and carry out activities themselves. This teacher knows that an effective science lesson should use an inquiry approach, and to her this means not giving the concepts directly but through questioning (as stated also by SO) to stimulate pupils.

In conclusion, teachers see a good science lesson as a pupil-centred activity. In this sense, all respondents have similar values towards primary science and this is reflected in the implementation of the science curriculum in their classrooms.

However, the issue here is whether teachers' concept of 'pupil-centred' involves merely giving pupils an activity, directing them and giving exercise questions to answer in order obtaining feedback.

In terms of classroom organisation, 12 respondents state that grouping children in mixed- ability groups allows a good science lesson, but two do not. Those who group pupils by mixed ability give similar reasons, i.e. so that the good pupils will be able to help the weaker ones and there will be co-operation among them. Of the other two respondents, one allows pupils to select their friends for their group. Another selects pupils, but he makes sure that each group is of mixed gender. The selection methods are quite varied. Some teachers' values on selection are quite contrary to others.

Most teachers select pupils to make up a mixed-ability group, but the respondent who lets pupils select themselves for a group believes that this allows pupils to the work better and the activity to run smoothly because they are able to tolerate each other. The respondent who believes in mixed-gender groups feels that certain activities might not be able to be carried out by one gender. For example, he states

that the girls might not want to handle worms whereas boys are more likely to! Most teachers believe that a good science lesson realises a mixed ability grouping (See, for example, Howe 1990).

Feedback in a good science lesson has three subcategories as drawn from their responses:

- Question-answer at the end of the session (seven respondents)
- Written exercise, test (eight respondents)
- During the activity (four respondents)

Seven respondents use a question-answer session at the end of the lesson and they say this enables them to know if pupils have understood the lesson:

*'When I do the question-answer session, if pupils are able to answer precisely then my teaching is okay and pupils understand what I have taught.'* (SH)

It is interesting to note that only four respondents are able to get feedback while teaching, e.g. through pupils' experimental results, pupils' discussion of results, and the presentation of the results:

*'When they are doing the experiment, I look at the groups which have finished and look at their results, and also when they present and in their class discussion.'* (NB)

This implies that teachers' pedagogical knowledge is used in their evaluation of their pupils and their teaching. However, it should be noted that these respondents still prefer the end-of- lesson technique of question-answer or written test for feedback. They do not consider if the evaluation or the feedback is at the end of the lesson, this is too late to make any adjustment in teaching. At the same time, most teachers agree that science lessons usually include practical activities, during which they are able to obtain feedback.



To conclude, in considering teachers' values about what constitute a good science lesson, the evidence suggests that they try to conform to what is suggested by the curriculum guide and use their own pedagogical knowledge to carry out successful science teaching. Teachers' statements generally reflected their own teaching strategies.

They tend to regard content knowledge as the most important aspect of their teaching. This is hardly a surprise because of the system of education in Malaysia, which is highly exam-oriented, with teachers under considerable pressure to produce good exam results. This implies that even though teachers mention different approaches and techniques that should be used, their actual teaching emphasise the need to achieve good exam results.

However, three respondents feel that it is most important to change attitudes among the pupils. They argue that a change of attitude will encourage pupils to become more responsible towards their learning, knowledge and skills, and be more positive towards science.

Six respondents feel that thinking skills are the most important pupil outcome in science. They state that by gaining thinking skills pupils will also be able to acquire knowledge, be able to solve problems and develop science process skills:

*'Thinking skills: what is more important is the thinking process, meaning that they can think and are able to solve problems and are able to give conclusions and opinions. I feel I give more emphasis to thinking skills because if they have thinking skills they will be able to do everything else and be able to have a strong thinking process.'* (SS)

One respondent felt that pupil self-satisfaction is the most important outcome in science:

*'A pupil gets self-satisfaction. For example, if he presents to his group and gives information, then he will feel proud. Then when he learn, he get new things, new experiences and will be able to apply them, not only in the classroom but outside. So when he get new things, he will be satisfied and he can applies it in his life.'* (MA)

This is an interesting argument, and shows that the values teachers' hold are not always the same, but are related to their personal circumstances. Teachers who have the responsibility for examination classes will have different values related to pupils' outcomes than those not teaching such classes.

Finally, in terms of teachers' values relating to ways of helping educate pupils in science, seven respondents stress the importance of extra-curricular activities, especially science clubs. These are seen to increase pupils' interest through the use of science gardens, science quizzes, poster competitions, model-making and scrapbooks. Other ways include having good science reference books in the library and teaching science across the curriculum:

*'Another way to influence pupils is through other subjects like Malay language. Also if a teacher teaches physical education, there is a science element. Now that physical education includes the health component, this is closely connected with science. It means that all subjects can help instil science.'* (SS)

It has already been suggested that if cross-curriculum approaches were used with the Phase 1 pupils, science teachers would benefit because it would be easier for the teachers to teach as well as for children to understand science concepts. This idea has actually been put forward by the curriculum developers but has not been monitored. Thus some teachers are not aware that it can be implemented.



### ***5.6.3 Teachers' beliefs towards the primary science curriculum***

To analyse teacher's beliefs on primary science education (Appendix 7), respondents were asked six questions. Three questions relate to teachers' philosophy and beliefs and how far these affect the implementation of the curriculum. Two further questions are concern teachers' beliefs in science as a process of inquiry and teachers' perceptions of how their science background enables them to teach science. One question seeks to identify the factors that influence the way they teach science.

Looking at teachers' philosophy of science, three pattern of thinking emerge:

- Future awareness (three respondents)
- Classroom-based needs (six respondents)
- Science as God's supremacy (three respondents)

12 out of the 14 teachers responded, but two teachers declined to answer. They did not feel comfortable with the question saying it was at too high a level for them to answer. There is then a question on teachers' belief in science. 12 teachers responded and three categories emerged:

- Science is important for our pupils
- Science is our life
- Science is related to religion

Teachers were asked how far their philosophy and belief in science affects the implementation of the primary science curriculum. Three patterns can be identified:

- Implementation with a future awareness agenda (three respondents)

- Implementation with a curriculum agenda (six respondents)
- Implementation with religion values (three respondents)

A question was also asked about teachers' opinions of science as a process of inquiry. All 14 respondents agree that science is a process of inquiry but they have different ideas about its meaning. Five respondents link science as a process of inquiry to doing experiments i.e. without experimenting, a pupil will not be engaged in a process of inquiry. Three others agree, but feel that it is not applicable to all pupils. For one respondent it means, 'searching' and for another it is experiential learning. One respondent relates science to pupils having a questioning mind, and two respondents related it to thinking skills.

In analysing teachers' opinions on their own science background and whether they feel that it has equipped them to teach primary science, nine respondents state that their background has equipped them to teach science. However of these nine, three feel that they have some problems with the content of the primary science curriculum. Five respondents think that their own science backgrounds did not equip them to teach the primary science curriculum.

Another set of questions to determine teachers' beliefs about science relate to influences on how they teach it (Appendix 8). Teachers' responses to pupils' influence can be categorised into four patterns of thinking:

- No influence on teachers (three respondents)
- Influenced by pupils' ability (eight respondents)
- Influenced by pupils' prior knowledge (three respondents)
- Influenced by pupils' attitude (one respondent)



Teachers generally believe that in-service training does influence the way they teach science. Out of 14 respondents, ten agree that in-service work influenced the way they teach science, and most state that it helped with the science process skills.

However, four respondents feel that in-service courses did not influence them.

13 respondents state that their science colleagues influence their practice, since there is a lot of discussion about strategies and the sharing of ideas. Only one respondent states that she does not think that her colleagues have any influence.

Other influences mentioned by respondents as individuals are:

- The Headteacher (one respondent)
- Time allocated too short (two respondents)
- Depends on topics of the lesson (two respondents)
- Textbook and teacher guide book (One respondent)
- Islamic religion (one respondent)
- Science equipment (two respondents)
- Other reference books and curriculum guide (one respondent)
- Self-preparation (one respondent)
- Note giving (one respondent)

### **5.7 Analysis of the Classroom Observations**

Two observations of each of the fourteen teachers were planned. However, in practice only ten teachers agreed to be observed twice and two teachers were only willing to be observed once. One teacher could only be observed once due to her being offered further study on a degree course before her second observation. One teacher could not be observed at all because she went on to further her studies before

the first observation. The teachers themselves determined the time available for the classroom observations. As a researcher, I felt that I needed to give them the freedom to choose whichever class and topic they wanted to teach and be comfortable when observed. Thus, the teachers determined the appointments. The only thing asked of them was that the period after the observation was a free period to enable an interview on the lesson observed. Generally, the time available for the lesson was about 60 minutes, a double period as specified in their timetable. The main aids to observation were audio recording and field notes of the activities of teachers and pupils. The checklist prepared for the classroom observations was quickly abandoned since most primary science teaching observed did not exhibit the components from the checklist. Thus, during the observation field notes were kept, indicating the flow of the lessons and the events happening during the lessons. This seemed to be appropriate, since the lessons observed did not show teachers' content knowledge requirement but rather revealed more of their science pedagogical content knowledge.

An interview session was held immediately after the classroom observations to facilitate reflection and because teachers did not wish it to be long after the lessons they had taught. This was not always satisfactory, because sometimes the time for interview was so short (about 30 minutes) due to other commitments of the teacher. Even in these circumstances teachers were reluctant to continue after school. Together, these sources of information were intended to allow close analysis of the approaches taken in the lesson, as well as giving an indication of the context of the lesson in terms of teachers' science pedagogical knowledge in implementing the curriculum.



### ***5.7.1 Analysis procedures***

The nature of the questions to be addressed in this part of the research required a qualitative approach to analysis, since the main objective of the classroom observation was to see how teachers implement the primary science curriculum at classroom level. Thus the observations were analysed using the same categories as those used in the interview sessions:

- Strategy used
- Pupils' development regarding science: science process skills, scientific attitudes
- Teacher's content knowledge

### ***5.7.2 An overview of the lessons***

Various aspects of the lessons are explored in greater detail in the analysis and interpretation sections. A detailed description of the classroom observations can be found in Appendix 10. A summary of the descriptions of the lesson with a focus on teachers' content knowledge is in Appendix 9.

### ***5.7.3 Strategies used in the lessons***

#### ***5.7.3.1 Constructivist approach***

In the 23 lessons observed only two teachers claimed that they were using the constructivist approach. NB used this approach in both lessons observed and SO used it in the one lesson that was observed before she left for further studies. The other teachers claimed that they were using the guided-inquiry-discovery approach as suggested by the curriculum guide.

In the three lessons which were described as constructivist, the teachers claimed that they were using the five phases of the approach, i.e. orientation, elicitation of ideas,

restructuring of ideas, application of ideas, and reflection (see, for example: Driver and Oldham 1986, Needham and Hill 1987, McGuigan and Russell 1997).

In all three lessons observed, the orientation phase consisted of teachers either asking questions or using teaching aids for orientation on the topics to be taught.

After the orientation phase, teachers did not elicit ideas and then plan activities but instead told pupils to do what had already been planned. Thus teachers' understanding of the constructivist approach is not clear: the notion of meaningful learning through children constructing their own learning seems not to have been understood by teachers.

What teachers actually understand by orientation is merely an introduction to a lesson and, as observed, this phase only lasted five minutes. For example, SO's orientation phase sought to direct pupils to the concept that living things need food. She asked two simple questions: 'What have you eaten during your recess time?' and 'Why do you eat?' These questions were asked to arouse pupils' interest and curiosity but the pupils saw it as merely the introduction to the lesson. This did not show that the teacher was aware that this point is a crucial component to stimulate interest and curiosity. She was not aware that this phase is the beginning of the process of recognising pupils' ideas about the materials presented. There was no other stimulus as her starting point. Thus, this teacher's view of the orientation phase is that it should pose questions to pupils to get the lesson started.

NB's technique in her orientation (two observed lessons) was somewhat different to that of SO. In both of her lessons, the orientation phase consisted of bringing to the class some teaching aids to catch pupils' interest but not to arouse curiosity. As in SO's lesson, there was no actual contact with the materials or events by the pupils.



This phase is important in encouraging children to explore their ideas within contexts which are relevant to their lives and experiences, and the key features of this phase is the provision of practical or familiar experiences (McGuigan and Russell 1997) which was absent from these teachers' observed lessons.

The teachers' 'elicitation of ideas' phases were all prepared prior to the lessons. The observation showed that teachers' understanding of this phase was for pupils to show their prior knowledge of the concepts that the teachers wished to teach. For example, NB asked pupils to identify animals which give birth and those which lay eggs. In another of her lessons, the pupils made predictions about magnetic and non-magnetic materials. In both lessons, pupils were given a prepared worksheet to record their observations or discussion. By using the worksheet, the children understood that the lesson required the correct answers for the teacher. SO gave a drawn concept map for pupils to complete to show their knowledge of the concept. It was not the children's ideas that were being considered here, but their prior knowledge. There was no opportunity for pupils to raise questions, nor was there listening and talking to them so that the teacher could identify children's ideas. Instead the teacher monitored pupils to complete the task given so that at the end of this activity they would be able to present the result or the discussion on the worksheet. This is not the type of elicitation envisaged by the constructivists. There was no elicitation of pupils' ideas which encouraged them to clarify their thinking. The activity given by the teacher was so structured that there was no opportunity for pupils to raise questions. This would actually help children to clarify what they already thought and knew and what they wanted to find more about. Hence, the activities provided by these teachers did not encourage pupils to raise questions but

instead invited them to answer questions given in the worksheet. As Hodson (1998) observes, in acknowledging and exploring pupils' ideas the aim should be to create opportunities for pupils to make their own ideas explicit, share them with others, subject them to critical scrutiny and test their robustness by observation and/ or experiment. McGuigan and Russell (1997) suggest that aspects of this phase should include: teachers' use of a variety of ways of finding out and probing children's ideas, the valuing of children's expression of ideas, and the use of children's ideas as the basis of formative assessment to inform subsequent teaching. These aspects were not observed.

In the 'restructuring of ideas' phase, teachers planned the lesson with an activity that made pupils realise the scientific concept they should have gained from the previous activity. SO introduced the terminology of herbivore, carnivore and omnivore, which she called 'the concepts'. After the introduction, pupils carried another activity to match the concept the teacher wanted them to acquire. It was with the same understanding that NB planned her 'restructuring of ideas' phase. In one of her lessons, this phase was observed to involve pupils making predictions on magnetic materials, then classifying magnetic and non-magnetic materials. In the other lesson, NB checked pupils' presentation of the activity in the elicitation phase and then gave further input and some explanation of the concept. It can thus be seen that these teachers' understanding of the restructuring phase is to prepare an activity to correct pupils' wrong answers (not concepts) from the previous activity. There were no elements of pupils testing their ideas; both the elicitation of ideas and the restructuring of ideas were pre-planned by the teacher. Pupils were not given any opportunity to plan or design a test to enhance their understanding of the concept.



They were also deprived of the opportunity to use their investigative skills to clarify and support their personal thinking. If pupils are allowed to test their ideas, they will be better able to understand the concepts, and it will be significant for them to link their ideas with scientific concepts. In practice, the concepts were not built upon or constructed by pupils but were still based on a teacher- directed activity, which forced concepts onto pupils with activity merely a means of getting pupils involved in the lessons. This phase should include components such as: 'learning opportunities make some contact with children's ideas', 'children are encouraged to support their ideas with evidence', 'children decide what constitutes evidence' and 'teachers promote children's learning by helping them gather and reflect upon relevant evidence and the implications for their previously expressed ideas' (McGuigan and Russell 1997). These were absent from the teachers' observed lessons.

In these lessons, the 'application' phase was used to produce an outcome from the lesson. For example, NB made pupils produce a scrapbook on animals' ways of breeding. In another lesson, she wanted pupils to find out more things that are magnetic and non-magnetic in the science room. For SO, the idea of 'application of ideas' was for pupils to make a classification of animals eating habits. This activity did not give pupils the opportunity to solve any problems in order to see if they could apply and transfer acquired knowledge and skills. According to Scott, Dyson and Gater (1987):

*'In the application phase, pupils are given the opportunity to use their developing ideas in a variety of situations, both familiar and novel. Thus new concepts may be consolidated and reinforced by extending the context within which they are seen to be useful. Application 'task' might include further experimental work, creative writing, discussion work and so on.'* (p. 14)

The final phase was 'reflection'. Reflection or review for the teachers meant the conclusion of the lesson. For NB both of her conclusions involved asking pupils questions about the lessons and inviting them to complete a concept map she had prepared. As for SO, her reflection was to give a verbal problem to be solved by pupils concerning the concepts learnt. Both lessons were concluded by the teachers themselves and not by the pupils. Hodson (1998) points out that reflecting on their own learning helps students to appreciate that conceptual change is involved in learning. In reviewing change in ideas Scott, Dyson and Gater (1987) invite pupils to reflect on how their ideas have changed by drawing comparisons between their thinking now and at the start of the unit. These elements of reflection were not present in the lessons observed.

## **Conclusion**

It seems that Malaysian primary teachers' do not have an in-depth understanding of the constructivist approach. What could be seen was a teaching strategy which was very much teacher-centred. Most activities were directed and instructional and there was no evidence to show that pupils might construct their learning using their own ideas. All activities were tightly controlled and planned. Even the making of a concept map did not allow pupils to demonstrate their creativity.

What was seen was the teacher regulating verbally the ideas or concepts that pupils should gain from the activities. This was done as early as the introduction phase. Pupils were told what they were supposed to learn from the activity. During the activity or the group discussions or the whole class discussions, pupils were controlled by the teacher — including the information under discussion and the direction of the discussion by the class or group. This was done through the



worksheet that had been prepared earlier. Another aspect of this controlled activity was that the teacher initiated the answering of questions but did not comment or suggest ideas. It took the form of exchanges within a sequence regulated by the teacher. The teacher chose children's answers selectively in order to arrive at the answer that was wanted.

Thus, central to all the lessons was the teacher's exposition. The teacher tightly controlled the talk and activity children were engaged in to serve the purpose of putting across certain ideas or concepts to be learned. The activities tended to follow input by the teacher, instead of developing from children's ideas. They were therefore seen as a means of illustrating the scientific concepts and act as a confirmation. As Drummond (cited in Frost, 1997) observes:

*'It is children's learning that must be the subject of teachers' most energetic care and attention—not their lesson plans, or their schemes of work, or their rich and stimulating provision —but the learning that results from everything they do (and do not do) in schools and classrooms.'* (p.10)

The teachers whose lessons were observed did not put the energy, care and attentions into the children's learning. Teachers need to change their perception from a teacher-centred to a pupil-centred approach in order to teach according to constructivist techniques. However, Loudon and Wallace (1994) show that it is not easy to change teachers' pedagogical beliefs and ideas they have used for a long time:

*'Clearly, "Malcolm" found it hard to participate in a programme which questioned his closely held values of teaching... ..In the end, the struggle resulted in an attempt to integrate the programme's philosophy into his image of teaching while retaining his investment and pride in his skill as a teacher.'* (p.652)

Therefore, the respondents' science pedagogical content knowledge could be described as inadequate as shown by this classroom observation evidence. Teachers

need to be helped in implementing a constructivist approach. The process of becoming constructivist must involve teachers in reconstructing their own knowledge of science and of science teaching (Louden and Wallace 1994). The classroom observation confirmed the misunderstanding of the constructivist approach, as the questionnaire and interview data (discussed in Sections 4.4.1 and 5.3.3.1 respectively)

#### *5.7.3.2 Guided inquiry-discovery approach*

Another approach to science teaching suggested by the curriculum developers is guided inquiry. Most of the teachers observed state that they frequently used this approach as it is appropriate and suitable for the pupils they teach.

In all the teachers' patterns of teaching, it was observed that all activities pupils were engaged in were structured. Most lessons observed used the following patterns or procedures:

1. The teacher explains the topic of the lesson as a brief introduction
2. The teacher briefs pupils on the procedures they should follow to gather their data or for observation
3. Pupils gather data or observe in the way prescribed
4. Pupils organise data in tabular form or any form required by the teacher
5. Pupils answer a series of questions about the data or observations (most of the questions involves science process skills)
6. Pupils present a conclusion of the activity (but mostly dictated by the teacher)

This common pattern shown by teachers did not reflect a true guided inquiry/discovery method. There was no element of pupils' discovery because teachers had



already explained the concepts in their introduction. The activities given were intended to involve pupils according to the curriculum's pupils-centred approach. Furthermore, the activities were intended to confirm the scientific concepts that pupils had to learn. To the teachers 'guided' means that they have to tell the pupils everything. They do not realise that this is not really a guided lesson, but is instructional teaching. In all the observed lessons, the teachers gave instructions for every step of the lessons' development. Most of the practical work observed consisted of following the 'recipes-methods' to verify theory or to illustrate concepts, and much of the practical was routine. Teachers understood that pupils should be encouraged to discover science for themselves with teachers' 'guidance'. The focus was on scientific method with an underlying assumption that pupils had no prior knowledge, so that all observations were perceived as neutral. The most significant problem was that, because the activities were relatively tightly controlled and the 'right answer' often apparent, there was little scope for 'discovery' in the true sense of the word.

The classroom observations confirmed that teachers' values in teaching science stressed activity-based learning through a guided approach as shown by the interview data (Section 5.6.2). However, as the observation shows, the guided inquiry approach used by teachers is misleading. According to Bonnstetter (1998):

*' Guided inquiry still has the teacher selecting the topic, the question, and providing the material, but students are required to design the investigation, analyse the results, and reach supportable conclusion'. (p.3)*

However, Bonnstetter adds:

*'A recent teacher workshop suggested that both student and teacher be listed under the procedures/design section. They pointed out that many times we must fluctuate between teacher and student directed at these interface components.' (p.3)*

This implies that Malaysian primary science teachers use traditional hands-on (cookbook's) science experience. The teacher directs the decision-making from topic to conclusion. This traditional methodology is rather predictable: everyone works on the same task, follows the same plan, and works towards the same correct answer. Therefore, teachers claim that they use a guided inquiry approach does not correspond to the developers' intention. This is shown in one of the respondent's lessons on electricity and is reflected in his comments:

*'I have to demonstrate first. I will show them how to connect the wires because if they do it, guided by charts in the workbook, they will not be able to do it. This way the pupil will make less mistakes and it will save time, and then they can proceed with the activity and follow the instructions.'* (MA)

An important component in scientific inquiry is that questioning occurs throughout the inquiry learning process (Chaille and Britain cited in Schmidt, 1999, Edwards 1997, Chiappetta 1997). Pupils must be able to ask questions about content according to their prior knowledge. Teachers could help pupils to experience inquiry learning through the KWLQ procedure (Schmidt, 1999) — K- What I Know, W- What Do I Want To Find Out, L- What I Learned, Q- More Questions.

The implication is that Malaysian primary science teachers' understanding of the guided inquiry approach is incorrect because it is based on the belief that pupils are unable to carry out any activities without their instruction. Furthermore, teachers' understanding of the guided inquiry approach needs to be developed in terms of its meaning and application of the approach, e.g. by applying the KWLQ procedure.

#### **5.7.4 Pupils' development in science**

To analyse teachers' understanding of the development of pupils in science, two aspects — science process skills and the scientific attitudes — were observed.



### **(a) Science process skills**

In teaching science process skills, the teachers exhibited similar patterns. The skills were incorporated during the activity but not taught in ways that helped pupils to acquire and develop the skills.

As an example, JZ's lesson was on plant respiration. The teacher gave pupils a general question, 'how do plant respire'? Then a boy answered, 'through leaves'.

When the teacher asked for any other answers and received no response, she immediately said that this was their hypothesis: 'Plants respire through leaves'. Thus, pupils were not taught that when they are doing an experiment, they should develop a hypothesis first so that in the experiment they will need to use other science process skills to develop the content or concepts. The lesson, in fact, was an instructed lesson and the science process skills were taught through the worksheet.

On one occasion pupils said they did not know the term 'inference'. The teacher explained the meaning and then gave the answer to the question on inference. This is further evidence that the development of the science process skills was geared entirely to the requirements of the examination, and not the learning needs of the pupils.

However, it should be noted that teachers were able to blend the science process skills with the science concepts by using basic skills such as observing, classifying and predicting. The problems teachers had related to other process skills such as hypothesising, controlling variables, and making inferences. The observations confirmed that some respondents faced difficulty in trying to explain to pupils how to develop a hypothesis. Furthermore, some of the respondents observed were not

able to explain which science process skills they wanted the pupils to acquire. Others just mentioned the relevant process skills somewhat unconvincingly.

Observations showed that teachers divorced scientific skills from the content and the context. A majority of teachers were observed setting exercise questions after, rather than during, the practical activity. Thus, the science process skills were not an integral and continuous part of the process, rather an arranged appendage. One main reason for this was the expectation of pupils doing well in the final examination in Year 6. The examination includes science process skill questions as one part of the paper. This encourages teachers to exhibit a 'teach for the exam' syndrome.

This analysis of science process skill acquisition by pupils confirms that the skills were not gained through the context of science; rather they were taught in a vacuum. The teachers' understanding of a process-led curriculum remained superficial, and factors such as the exam influenced the way teachers approached skills acquisition. The observation confirmed the importance teachers gave to objective (iii) 'develop scientific skills in an inquiring manner' (Section 4.3), pupil's most important characteristic as (ix) 'the child should be able to know some simple basic science process skills' (section 4.5.1) and the various methods used to develop pupils' scientific skills (section 5.3.3.2a). However, the development of the skills are not as suggested by Harlen (2000) (discussed in Section 5.332a). This indicates that primary science teachers in Malaysia lack important science pedagogical knowledge.

#### **(b) Scientific attitudes**

In the Malaysian context of the primary science curriculum, scientific attitudes are not given priority. For all teachers observed, these were developed co-incidentally during the activity and teachers did not emphasise or ever mention them to pupils.



One respondent state that she had more important things to think about and she forgot this objective. She added that pupils would gain it through their activities in the lessons. There is no doubt that these attitudes are developed through scientific activities, but by not realising this element, teachers do not take advantage of the situation to develop pupils' scientific attitudes from an early stage.

The observation confirmed the finding of the interview data that the development of pupils' scientific attitudes (Section 5.3.3.2 b) is not important. This is also confirmed by the questionnaire result that only 3.1% of teachers rank pupils' characteristic (xi) 'show a set of scientific values on which to base his/her behaviour' as the most important skill (Section 4.5).

The interpretation here is that these teachers' thinking about, and understanding, of the importance of scientific attitudes needs to change. Pupils' attitudes affect the willingness of individuals to take part in certain activities, and the way they respond to persons, objects or situations (Harlen 1996). Children should be taught scientific attitudes so that they will be drawn more towards science as a subject and will also have a better understanding of science and further their interest in the subject. This attitude would help pupils to think and work scientifically and teachers should take it more seriously, not just as an element to be acquired. Teachers are responsible for developing these attitudes through encouragement and examples.

#### ***5.7.5 Teachers' content knowledge***

In analysing teachers' content knowledge, an overall view of the lesson was taken.

The teachers' content knowledge component was not great due to it being seen as a process rather than a content-led curriculum. However, it was observed that most of the content given to pupils was correct, covering such diverse topics as animals'

eating habits, conductors and insulators, energy and forces. A summary note of the observation is given in Appendix 10.

Teachers' content knowledge was observed when:

- Teachers presented content accurately (during explanation) (seven respondents)
- They linked conceptual content to children's informal experiences (seven respondents)
- They defined terms and monitored their use (six respondents)
- They linked the present lesson conceptually to a previous lesson (four respondents)
- They asked for conceptual understanding, rather than just for factual or procedural knowledge ( three respondents)
- They used examples (two respondents)

Only a few respondents (three in three lessons) asked for conceptual understanding. Most of the questions teachers asked sought more factual or procedural knowledge. Another factor that showed the limited application of teachers' content knowledge was that only two respondents were used examples, whereas they ought to use many examples, analogies and metaphors in their teaching.

Most of teachers' content knowledge observed was accurate. They explained verbally or with the aid of transparencies. This was done by all respondents during the discussion of results or the conclusions to the lessons. Also teachers linked conceptual content to children's informal experiences when they asked questions on the application of a concept in pupils' everyday lives. In many lessons teachers placed an emphasis on the definition of terms.



Thus, in conclusion it can be stated that teachers' content knowledge reflects how they think and what they understand to be important, and is given mostly by transmission through definition or explanation during the discussion and conclusion of a lesson. However, it might be illuminating to analyse Malaysian primary teachers' content knowledge in more focused and detail research in future.

## **Chapter 6     DISCUSSION**

### **6.1 Introduction**

In this chapter the quantitative and the qualitative data are discussed. The findings are compared and an interpretation of the implementation of the Malaysian primary science curriculum at school level is offered. The implications that can be abstracted from the comparisons are considered.

### **6.2 The Malaysian Primary Science Curriculum Objectives**

Both the quantitative and qualitative data provide strong evidence that a majority of teachers' agreed that a child should be given the opportunity to develop thinking skills to increase intellectual capability, and that this is the most important objective in the primary science curriculum. The second most important objective varies between the qualitative and quantitative data. A majority of teachers in the quantitative data sample selected objective (v), which states that the child should be given the opportunity to gain knowledge and understanding of science concepts and facts in order to understand both themselves and their environment. The qualitative data sample produced various responses. In general, teachers feel that the important objectives for pupils relate to gaining science knowledge. However, there are also respondents who believe that the acquisition of scientific skill and attitudes is also vitally important. It can be concluded that teachers see that it is important for pupils to develop thinking skills in order to gain science knowledge. Thus, these two objectives (i.e. objective (iii) to develop scientific skills in inquiring manner and objective (v) to gain knowledge and understanding of scientific concepts and facts in order to understand themselves and their environment) are both important for the



primary science curriculum. Ironically, both in the quantitative and qualitative data samples, teachers do not regard problem-solving ability as an important objectives (only two respondents give it as the second most important objective), although, presumably, there should be a relationship between problem-solving skills and the development of thinking skills. Teachers do not feel that the objective is important, and through both observation and interview it was found that teachers do not really let pupils set and solve problems by themselves. Problems are pre-set by teachers and the methods of how to solve them are given to the pupils. Thus, teachers do not implement this objective as they only give the problem as a prescribed activity. This may be due to their underestimation of the potential of their children for solving problems on their own. It also implies teachers' limited understanding of the meaning of problem-solving and how to use problem-solving methods in their classes and may explains their lack of focus on this objective during the interviews. In terms of the objectives that teachers found difficult to implement, both sets of data showed these were those that concern:

- developing thinking skills to increase intellectual capability
- developing scientific skills and attitudes in an inquiring manner
- gaining knowledge and understanding of scientific concepts and facts in order to understand themselves and their environment
- developing the ability to solve problems and make responsible decisions

In relation to objective (v) developing the ability to solve problems and make decisions, teachers' found it difficult to implement. This implies that when they could not implement it, the objective was not regarded as an important objective as

explained above. However, teachers' implicitly know that it is important as it is considered in the objectives that are difficult to implement.

The findings indicate that teachers know what children should gain from the science curriculum. However the difficulties they face in implementing the important objectives is reflected in their responses in the interview especially concerning development of pupils thinking skills. Majority of the sample interviewed agreed that it is difficult to develop the above objectives and this is caused by a complex combination of factors. The data showed that majority of teachers regard their pupils as passive and need to be instructed. In this context teachers' feel that the environment mainly causes their pupils the inability to gain those objectives. Teachers believe that as these pupils are from rural areas they have inadequate exposure in science materials and also their low social economic status prevent them to achieve the objectives laid down by the curriculum developer. They also believe that pupils have poor attitude towards learning science, unable to think for themselves and need to be given instructions. Therefore, the perception teachers have on their pupils' hinders implementation of some important objectives in primary science education. As indicated in the interview on factors influencing the way they teach science, a majority of the sample agree that pupils' ability, attitude and prior knowledge have great influence. Many factors influence the degree to which teachers are able to implement the curriculum as intended by the developers. For example, understanding of the primary science curriculum objectives to be achieved, teachers' primary science pedagogical knowledge and the supplies of resources and materials. Thus, in the Malaysian context it is essential to help



teachers acquire the body of complex knowledge and skills that need to be integrated into everyday practice.

The primary science curriculum is still considered to be a new reform in Malaysia, and teachers still find it difficult to implement it. Wallace and Louden (1992) argue that, when confronted by new problems and challenges, a teacher struggles to resolve them in a way that is consistent with the understanding that he or she brings to the problem at hand. This applies to Malaysian primary science teachers when handling the curriculum implementation. The understanding teachers bring to solve the problems is influenced by their pedagogical content knowledge. Teachers need not only a complex knowledge base to implement an effective programme, but they also require the ability to transform knowledge into pedagogical content knowledge (Peterson and Treagust cited in Baker 1994). This actually means how teachers translate and interpret content in their teaching. Smith and Neale's (1989) • description of the pedagogical content knowledge appropriate for primary science includes knowledge of pupils' prior concepts, of strategies for teaching content, and of ways to shape and elaborate content, for example by using appropriate examples, explanations, analogies and metaphors.

The difficulties teachers face in implementing the primary science objectives, which include thinking skills, scientific skills, science concepts and problem-solving abilities correspond to Smith and Neale's description of pedagogical content knowledge. This is related to children's prior concepts and the strategies for teaching the content. It shows that the difficulties arise due to the teachers' lack of pedagogical content knowledge. However, a majority of teachers blame their difficulties either on pupils' lack of ability or attitudes (the 'spoon-feeding

syndrome). Only two teachers from the sample admit the lack of their own knowledge in science teaching as a reason for not implementing the curriculum effectively. It appears that it is the teachers' orientation towards science as a body of knowledge that is the major cause of the problems they face.

Smith and Neale's (1989) study found that:

*'Teacher's knowledge of the content, their translation of that content into appropriate and flexible usage in lessons, their knowledge of children's likely preconceptions to be encountered in lessons and of effective teaching strategies for addressing them, and especially their beliefs about the nature of science teaching, all proved to be critical components in the changes they were able to make in their teaching.'* (p.17)

Thus, the difficulty that teachers feel they face are actually due to the lack of pedagogical content knowledge, which includes the components identified by Smith and Neale (1989). Other researchers in the field of teachers' pedagogical content knowledge come to similar conclusion (See, for example, Summers 1994, Baker 1994, Stofflett 1994, Van Driel, Verloop, and de Vos 1998). As the interview data showed, the in-service courses given to teachers are limited to discussing teaching strategies and the explanation of the science process skills that should be taught to primary pupils. They admitted that these were explained as lectures but not on how to implement it in the classroom. As Joyce and Showers (cited in Harvey 1999) propose, one of the pedagogical elements needed for an INSET to have an impact is 'coaching for application' i.e. support while practising the new skills on the job. Therefore in the context of the Malaysian primary science teachers to understand and achieve the primary science curriculum objectives they need classroom support to realise the new skills in order to achieve the intended objectives. This implies that the design of the INSET needs to consider the element of 'coaching for application' in the programme. However, this programme need to be effective and those who are giving the ongoing classroom support must be also be competent.



### **6.3 Malaysian Primary Science Teachers' Perceptions on the Nature of Primary Science Teaching**

In the context of the Malaysian primary science curriculum, teachers' perceptions of the nature of primary science teaching will be discussed in the context of their science pedagogical knowledge. This will be related to the teachers' understanding of teaching approaches, pupils' characteristics, the roles teacher play, and pupils' classroom organisation in science lessons. The relationships between these perceptions and how they influence the implementation of the curriculum will be discussed.

#### ***6.3.1 The teaching approaches***

The curriculum guide indicates that the teachers are to use a guided inquiry and a constructivist approach. The teaching of science as enquiry, according to Schwab (1962), could be considered as 'teaching as enquiry' and 'science as enquiry'. To him, 'teaching as enquiry' means a process of teaching and learning which is itself an enquiry, and 'science as enquiry' means instruction in which science is seen as a process of inquiry (p.65). Therefore, in the context of the approach that is suggested for use with the Malaysian primary pupils, it is Schwab's concept of 'science as enquiry' which is important. Teachers should have knowledge of instruction methods in which science is seen as a process of inquiry. The aim is not only the clarification and inculcation of a body of knowledge but the encouragement and guidance of a process of discovery on the part of the student (Schwab 1962, p.66). Thus, teachers should also have knowledge of how to guide pupils in the process of discovery. According to Wellington (1981), discovery learning can be summarised as

child-centred, dialectic, open-ended, skill-oriented (process based), psychologically-based, concerned with the nature and philosophy of science, and emphasising a wide range of educational objectives, e.g. attitudes and values, and active learning.

Wellington (1981) also discusses the problems associated with discovery learning.

These include the limited availability of apparatus, large class sizes, classroom control problems, and examination pressures. Wellington further argues that there is also the danger of poorly guided discovery learning. He explains that pupils might realise that they should discover a right answer and, especially the more intelligent ones, that their exciting open-ended investigations have only one right answer, i.e. the answer given by 'normal science'.

The approach that teachers often use, as the qualitative data show, is the so-called guided inquiry approach (71%). They maintain that the approach is suitable for A and B classes but not for the weak classes. However, the classroom observation data show that the 'poorly guided discovery' approach is common. Teachers do not actually guide but rather instruct pupils during the activities in order to get to the 'right' answer. As we have seen in the observation analysis, teachers structure their lessons with few opportunities for pupils actually to develop their problem-solving skills, which should be a key part of discovery learning. It seems clear that if pupils are actually engaged in problem-solving skills, they should have a lot of questions either for their peers or for the teacher. But since problem-solving skills are not in the teachers' 'framework', they are not considered to be part of the discovery approach even though this is one of the primary science curriculum objectives. There has been no dialogue between teachers and on how pupils should solve problems; instead teachers explain every single detail of what pupils should do. This



emphasises the role of ‘poorly guided discovery’ in Malaysian primary science teaching.

For those teachers using the constructivist approach (which is not favoured by teachers) there is a basic misunderstanding of the meaning of the approach. As discussed in the classroom observation analysis, this approach, like the inquiry discovery approach, is teacher-directed and tightly controlled. Teachers’ understanding of the consideration of children’s ideas is not consistent with the constructivist view. In the constructivist approach, considering children’s ideas means encouraging the active construction of meaning by starting from a pupil’s own ideas and providing opportunities for building on and modifying these towards a scientific theory (Driver and Oldham 1986). The teachers, however, simply rely on the answers they get from pupils during the lessons’ introduction. These answers are not used to build pupils’ conceptual understanding. But when asked if they consider children’s ideas, 93% of teachers state that they give full consideration. The meaning teachers attach to considering children’s ideas in teaching science is not the same as the meaning implied in the constructivist approach. The same finding emerged from the quantitative data on teachers’ views of the constructivist approach (Section 4.4.1). The analysis shows that even though teachers agree with all the criteria in the constructivist approach, they do not agree on their relative importance. There is thus a discrepancy between the qualitative and the quantitative data on the constructivist approach. The quantitative data show that the suggested curriculum is being implemented as intended, with a constructivist approach being applied in the classroom, but the reality is that teachers have many difficulties in its application. The main difficulty, as shown by the observation and interviews is teachers’

understanding of the meaning of the approach; they do not have the science pedagogical knowledge of constructivism to teach science effectively.

Another link to a constructivist approach is the idea of ‘pupils as active learners’.

However, the meaning of ‘pupils as active learners’ given by teachers depends on the activities they choose where pupils are involved in experimenting (which is actually practical work), the teachers maintain that pupils are involved actively in the lesson and take the role of problem- solvers (but the problems are prescribed and not developed by pupils themselves). There is no mentioned of providing opportunities for children to be involved in the learning process by actively working on their own ideas.

However, active participation in learning is regarded as a key important issue in science teaching. Both the qualitative and quantitative data reveal agreement among teachers on the importance of pupils’ active participation during science lessons.

79% of teachers interviewed state that they attach importance to pupils’ active participation. 72% of respondents to the questionnaires claim that the idea of pupils as active learners is applicable in their classroom. Here ‘active participation’ means pupils being involved in the activities provided by teachers. Teachers also emphasise that it is only applicable to high-ability pupils with good interaction qualities, but there is no mention of children actively working with their own ideas. This confirms that the approaches used are mainly teacher-directed.

The above analysis shows that the teaching approaches suggested by the curriculum developers are not realised in the classroom even despite the claims of teachers to the contrary. However, when teachers were interviewed about what they view as a ‘good science lesson’, their responses included: having group activity, doing



experiments, and using a guided inquiry approach. What is clear is that teachers' understanding of a guided inquiry approach is not consistent with the meaning given by Schwab (1962) (see also, for example, Bonnstetter 1998). For two respondents, the guided inquiry approach means giving pupils enough material and explanation, and stimulating them through questioning so that they anticipate what they are going to be taught. Only one respondent said that the guided inquiry approach involves pupils raising problems and carrying out the activities to aid understanding. These different meanings that teachers have regarding the guided inquiry approach show that they relate their understanding closely to what they are doing in the classroom with their pupils. Observation also shows that teachers do not use any element of problem solving in the true sense. Another example of good science teaching is said to be group activity. For teachers, this includes information-searching, discussion and finally presentation to the whole class. However, a majority of teachers believe that doing experiments (i.e. practical activity) is viewed as good science teaching. Doing experiments means that pupils are given materials and procedures either in worksheets or workbooks. While pupils are engaged in the work, teachers monitor and help those groups having difficulty. Experiments are done in groups of six or seven pupils, and pupils answer the questions printed in the worksheet or workbook, which are discussed at the end of the lesson (to get the 'correct' answer). This is how teachers understand a 'good science lesson' and it shows that teachers acknowledge the importance of child-centred teaching. The data suggest that the approaches suggested were inadequately implemented, even though the teachers observed are experienced teachers. They do not have enough background in science or in science pedagogical knowledge.

However the qualitative data on factors influencing the way teachers teach science revealed that a majority of teachers belief that pupils ability and their prior knowledge has a great influence. In this context, these teachers in general agree that pupils from rural areas are of average or low ability. This will effect the way they teach science. Thus teachers will find difficulty using the strategies recommended by the developers.

The short in-service courses given to teachers to introduce the curriculum and the suggestions of approaches and strategies through lecture methods are not adequate for the effective implementation of the curriculum. There is evidence from the qualitative and quantitative data to support this argument. A majority of teachers agree that the in-service courses they attended mostly help them in the development of pupils' science process skills but there was no mention of the support on the strategies on teaching science. This indicates that primary science teachers need more support through better in-service courses that focus on changing teaching models and strategies. Harvey (1999) recommends that INSET for the pedagogical process should be phase in order for teachers to gain professional learning through 'stages of development'. The first stage in his recommendation is the 'security phase' and one of his recommendations in the workshop is that it should focus on building confidence in subject knowledge and technical proficiency with apparatus and that workshop inputs themselves should model activity-based learning. He further recommends that teachers should be provided with concrete models of practice in the form of demonstration lessons and that discussion of these might deal with personal and logistical implications of implementation.



Therefore in the context of the Malaysian in-service courses for the teachers teaching primary science need to be improved. An initiative towards developing teachers professional development should consider teachers' 'stages of development' (Harvey, 1999). This might improve teachers' pedagogical content knowledge as teachers' understanding is develop in stages and activity based learning will help teachers in implementing a new curriculum.

### ***6.3.2 Teachers' perspectives on pupils' characteristics in science learning***

In order to discuss further the issue of teachers' science pedagogical knowledge, we will consider teachers' perspectives on pupils' characteristics in science learning. In both the qualitative and quantitative samples, teachers attach importance to the development of science process skills. The three most important skills chosen were in the science process skill domain. The interview data on the development of science process skills revealed similar findings. There were various ways of incorporating these skills in the activities. The majority of teachers interviewed claimed that the skills are integrated into the lesson. As the classroom observation analysis showed, the science process skills were taught by the pupils answering questions on prepared worksheets. In practice, further questions on science process skills were given after the activity had been completed, and these had to be answered as a subsequent exercise.

It is clear that teachers give too much importance to science process skills thus depriving the children of other skills highlighted by the curriculum developers. This reflects the format of the examination, which focuses on one particular aspect of science process skills in the exam questions. Therefore, there is bound to be an imbalance in the development of pupils' characteristics in science by the end of the

primary school. Teachers will not develop critical and discriminating attitudes nor will they be able to produce enough pupils who are creative and inventive. We must have pupils who are able to talk about their opinions and convey their meanings clearly and accurately. We also need pupils with the ability to search for and acquire information. Even though these characteristics are regarded as important, they are not realised in the classroom.

As mentioned earlier, teachers prefer the inquiry-discovery approach, which most of them regard as being through experimental work (actually, practical activity). They also feel that through experiment (practical activity) science process skills will be developed in pupils. However, the key issue is: do the teachers actually understand the links between learning and the role of practical work? Our analysis of the classroom observations shows that science process skills are taught through prepared worksheets with questions on particular science process skills. Therefore, teachers need to understand how to achieve a balance between process, content and context in order to provide their pupils with the opportunities to relate actual experiences to ways of comprehending the environment (including interpreting and making sense of phenomena in terms of school science ideas), and to explore the range and limits of certain models and theories through investigation (Brook, Driver and Johnson, 1989). Thus, if teachers see learning science as knowledge construction, the development of pupils' science process skills should also be seen in this light As Brook, Driver and Johnston (ibid.) state:

*'If science learning is about pupils constructing these ideas for themselves and seeing them as useful, the role of the teacher and of the teaching materials is to help pupils' shape their understandings progressively towards a science view'.  
(p.77)*



In order for Malaysian primary science teachers to be able to understand the importance of the balance between content, process and context, which might be achieved through the constructivist perspective, they need to be encouraged to change their views on teaching strategies. Hopefully, teachers will then be able to see that science process skills are not content-free and they will help pupils to develop science concepts constructively.

Another key issue is teachers' understanding of practical work, which they regard as synonymous with experiment. Generally practical activities do not involve making any hypothesis or controlling variables but merely carrying out activities through observation and classification. Teachers feel that experiments help to enhance pupils' interest — one respondent stated that his class showed great enthusiasm when he introduced practical activity. Many respondents share the same view. Hodson (1990), in his critical analysis of practical work in school science, revealed that the claim that practical work has motivating power to stimulate interest and enjoyment is misleading. He suggested that motivation is not guaranteed by simply 'doing practical work' unless children are provided with interesting and exciting experiments and they are allowed a measure of self-directed investigation. He further added that learners need an interest in, and a commitment to, the learning task that conventional practical work frequently does not provide. The commitment comes from personalising the experiment, by identifying for oneself a problem that is interesting and worth investigating, or by designing the procedure to be adapted. Therefore, the claims of the respondents in Malaysia are superficial in the sense that there is no element of self-directed investigation or personalising the experience;

pupils simply investigate teachers' problems and follow teachers' procedures. As Hodson (1990) states:

*'The real source of the problem is that teachers pretend to children that the purpose of such lesson is to engage in scientific enquiry (to discover) when the real purpose is to promote the acquisition of particular scientific knowledge (the established facts). Thus although teachers refer to discovery they really mean "re-discovery" they have it in mind that children will "discover" something in particular.'* (p.37)

The problems identified by Hodson (ibid.) were also observed in the classrooms of Malaysian primary science teachers, where all the experiment/practical work consisted of teachers' procedures. Thus the claim that they will motivate pupils has no real basis.

The Malaysian primary science teachers' views on the children's characteristics in science lessons are very much related to the priority given to the objective of developing pupils' science process skills. Thus, when these skills are considered to be the most important focus in science learning, teachers give emphasis to practical work (experiment/ activities). It is the teachers' understanding that practical work will enable pupils to gain scientific skills, i.e. the skills pupils should acquire in science learning.

Even though it has been argued that practical work can attain goals within the cognitive, affective and practical domains (Hofstein 1988), Wellington (1998) puts forward counter arguments. According to him, practical work is not a good tool for teaching theories, as theories are about ideas and not things, and they involve abstract ideas which cannot be physically illustrated. This implies that involvement with materials does not guarantee a logical intellectual development. Wellington further argues that not all pupils will develop an interest and become motivated



towards science, but instead be 'turned-off' by science if it 'goes wrong' or they cannot see the point of doing it. This is especially so if they are accustomed to the routine of 'rediscovery' and getting the 'correct' answer. Furthermore, the claim that it will help with their practical skills is countered by Wellington, who states that there is little evidence that the skills learnt in science are general and transferable or that they are of vocational value. Such arguments suggest that doing practical in science does not necessarily guarantee pupils' intellectual development.

Pupils were observed to share a single apparatus between a group of six or seven. A large number of pupils in a group does not give opportunities for everyone to handle the apparatus and does not guarantee that everyone will attain practical skills. The teachers themselves admit that there is a lack of science apparatus and equipment. This is in accord with teachers' simplistic views that practical work will enhance pupils' practical skills and that a lack of apparatus is one factor that will hinder their development.

Another key issue concerns teachers' opinions on enquiry learning. All teachers state they use a guided inquiry learning approach, and that it is best to teach science using practical work (experiment/activities). Millar (1998) discusses the notion that 'enquiry learning' in science will result in explanations 'emerging' from observations if these are carefully structured and sequenced by the teacher and the teaching scheme:

*'It is that the purpose of much practical work in science is to build a bridge - between the realm of objects and observable properties on the one hand, and the realm of ideas on the other. If we do practical work "because science is a practical subject", then it is almost equally true that we do it "because science is a theoretical subject".' (p.29)*

This implies that pupils should not only understand the scientific method per se but also scientific knowledge, which will be obtained as outlined by Millar above.

Teachers need to modify their understanding of the approaches they believe will help with pupils' scientific learning. A further implication is that there should be a communication strategy to help pupils understand scientific ideas. It was observed during science lessons that there was a lack of communication in the science classroom. Sutton (1998) suggests that pupils need time and freedom to do their own mental work, to summon up their 'grasp of mind' and to take possession of what they have seen and heard. This, he states, can help practical work. He suggests that pupils should come out with their own expression 'of what these people are on about' and report that as the outcome of the lesson. He further suggests that teachers should coach pupils in more carefully argued communication at the reporting stage. The evidence clearly shows that the reporting by pupils involves giving the 'correct' answer. Even though teachers express a belief in enquiry learning and state that explanation will emerge from observation (Millar, 1998) they misinterpret this by providing an explanation for the pupils' observations. Teachers need to give space within a less tightly controlled science lesson, so that the children can do some mental work on their own. A rigid, structured lesson does not help pupils develop their potential, either in the cognitive or the practical domains.

Another issue that emerges from practical work concerns the assessment of science process skills. As already explained, Year 6 pupils are assessed on the science process skills. One respondent mentioned that this assessment should not only be conducted in Year 6 but it should also be done continuously from Year 4. He feels that if the assessment starts as early as Year 4, pupils will be able to grasp the science process skills early, and by the end of primary schooling will be familiar with scientific method. As for the teachers, he said that not only Year 6 teachers, but



all teachers from Year 4 onwards, should be able to teach process skills. These opinions should be taken seriously in order to help teachers determine pupils' strengths and weaknesses in the skills continuously from Year 4 to Year 6. As Hofstein (1988) observes:

*'Continuous assessment on several occasions throughout the year is necessary adequately to cover the variety of tasks and skills, which comprise a total programme of practical work. With this involvement in the continuous assessment of practical skills, the teacher is likely to develop a greater awareness of the scope and objectives of the laboratory work, as well as identifying student strengths that otherwise may not have been reflected in more conventional assessment'. (p.208)*

This implies that continuous assessment is good for both pupils and teachers and that the Curriculum Development Centre (CDC) should consider it seriously. It might also help to ensure that pupils entering the secondary school will not shy away from science subjects but be more confident in doing science at secondary level.

The conclusion that can be drawn is that Malaysian primary science teachers' understanding of practical work reflects the focus and importance they give to science process skills. Thus, Malaysian teachers have a very simplistic view of the importance and objectives of practical work. They see practical work as a mean for pupils to gain the cognitive, affective and practical goals, especially the science process skills. Additionally, there is a bridge between cognitive and practical development that should be considered when doing practical work. However, teachers do not see the bridge; rather they make science process skills an appendage of science learning, whereas the two should be linked, integrated and embedded throughout the lesson. A major investment in in-service programmes for teachers is required to develop science pedagogical knowledge and to ensure the implementation of the science curriculum as the curriculum developers intended.

### ***6.3.3 Roles teachers play and pupils' organisation in science classrooms***

Both the qualitative and quantitative data reveal similar findings on the roles teachers play in their science lessons. The role of information-giver is frequently used. However, the qualitative data reveal that the most frequent role is that of 'guide'. As the qualitative data analysis shows, this role is very much linked to the strictly instructional nature of the lesson.

Both sets of data confirm that the roles teachers most frequently play do not justify the claims made by teachers about the approaches they use. As discussed in the quantitative data analysis, the constructivist approach demands a different role from teachers. Inquiry approaches also demand roles which enable pupils to grasp science concepts for themselves. The curriculum developers suggest both of these approaches, but the data suggest that teachers' believe more in the role of information-giver. This role corresponds to Malaysian exam-oriented culture.

Teachers believe that by dispensing information, they will help pupils to answer the science content knowledge question in their examinations. Thus the role teachers assume is related to the constraints of the exam culture.

The roles of teachers are also reflected in their classroom organisation. As the quantitative data shows, a majority of teachers organise their pupils mostly for whole class teaching and some small group work. This implies that in order to play the role of information-giver, teachers need to focus on whole class teaching. In this situation pupils are attentive and listen passively to the teachers' explanation. This is again confirmed by the ways in which the information-givers set tasks for pupils. They set tasks that are the same for all pupils and that do not take account of individual differences. This is obviously easier in whole class teaching: it is easier for the



preparation of the lesson and is less time-consuming than having to prepare different activities for different groups of pupils. This was also observed in the classrooms, where all the teachers observed used the same activities for all pupils, even though the teachers in the quantitative sample claimed that a majority of them give pupils tasks that stretched their ability.

The analysis shows that six out of 14 respondents claim that pupils control learning for themselves and two out of these six claim that they let pupils control learning in all their classes irrespective of their ability. However, the overall data show that a majority of teachers control the children's learning. This evidence was also confirmed by the classroom observation. It was observed that all teachers guided their pupils closely in following instructions given to them in a worksheet or workbook. Pupils were observed waiting for teachers' instructions in all the lessons. This shows that teachers expect pupils to carry out the activity prepared and answer the follow-up questions. A majority of respondents state that they control pupils' learning in all classes irrespective of ability. As commented by one respondent, in the weak class, he has to help pupils by showing them how to glue pictures and classify them. This confirms the observations that the roles teachers play and their classroom organisation are related to the control of pupils' learning in science lessons. When a teacher acts as an information-giver, he actually controls most of the pupils' learning.

It can be concluded that the teaching of science in primary schools still follow traditional methods, which are teacher-centred. What can be regarded as pupil-centred activities are the follow-up activities pupils carry out. The meaning teachers give to pupil-centred learning is synonymous with pupils carrying out the activity

provided, but without the element of pupils developing the conceptual meaning from the 'prescribed' problem-solving activity, which should be part of their own learning. The idea of a 'guided' inquiry-discovery approach is vague for teachers. It should be made clearer, and detailed explanations should be given so that teachers understand the concept of guided science learning (See, for example, Bonnstetter, 1998) and ensure that it is different from the traditional school science teaching which has proved unsuccessful in the west (See, for example, Wellington 1981). Teachers need to change the whole concept of their understanding of science teaching in relation to both the inquiry –discovery approach and the constructivist approach. If teachers could change to a constructivist approach, they would also satisfy the inquiry-discovery approach, since both require pupils to understand science concepts when they construct meaning through activity.

#### **6.4 Barriers to Implementing Primary Science**

In discussing the barriers to implementing the primary science curriculum in Malaysia, the influences of certain factors emerging from the quantitative data will be considered. These are categorised as school, classroom, self, administrative and bureaucratic factors. The administrative and bureaucratic factors include the Headteacher, the District Education Office and the Teacher Activity Centre. The Headteacher has 'strong influence'. The District Education Office and the Teacher Activity Centre have 'some influence' but only in the implementation of the curriculum. 13 out of 14 respondent state that they have strong support from their Headteachers, especially in trying to provide resources and science equipment within the budget specified by the Ministry of Education. However, problems include delays in getting the materials or resources on time and complex ordering procedures



resulting from government legislation. Teachers also state that sometimes the materials are received long after the topics have been taught. However, two respondents say that they have received moral support for teaching science since the Headteacher is one of the key science personnel for the district. They state that he discusses their teaching strategies and the examination format for science. This, they claim has helped them to implement the curriculum. We conclude therefore that teachers need more support in pedagogical and instructional needs as well as more resources and materials.

The quantitative data indicate that the District Education Office, and the District Education Officers for science have some influence, and this is supported by the qualitative data. The District Education Officers play a major role in providing on-going continuous short in-services courses for primary science, but this depends on the Officer's own attitudes and beliefs towards science. For a majority of teachers, the quantitative data suggest that the District Education Office influence is restricted to the initial orientation courses for the introduction of the curriculum and some subsequent short in-service courses. However, the Teacher Activity Centre is reported to have had little or no influence in curriculum implementation. This is supported by the qualitative data: most teachers state that the main function of the Teacher Activity Centre is to provide a venue for courses. The Centre could play a major role in the implementation of the curriculum, especially in providing courses, if it was allowed to do so. It should be a centre where teachers meet to reflect on and discuss their problems, especially the instructional problems related to teaching science. The Teacher Activity Centre Officer could arrange for teachers to have regular meetings specifically for this purpose, with consultants available for specific

needs. This would help not only the experienced teachers but also newly qualified ones who could share experiences, problems and difficulties when teaching science. This is one way of improving teachers' science pedagogical content knowledge for more effective science teaching.

The school category includes the Head of the Science Department, levels of provision, co-operation among teachers, and the syllabus. The quantitative data indicate that the Head of the Science Department has a strong influence on implementing the curriculum. The qualitative data shows that most of the respondents interviewed are heads of science who claim that they help their colleagues to implement the curriculum through discussion and the sharing of teaching resources.

The level of resource provision has a strong influence on implementing the curriculum. It is claimed that this is presently insufficient in most schools (62.5%). This implies that a lack of resources could be a serious barrier to implementing the curriculum. This view is supported by the qualitative data, with a majority of respondent identify a lack of apparatus and materials.

Co-operation among teachers has a strong influence on implementing the curriculum. A majority of the respondents state that their colleagues help by discussing the teaching strategies, that they find difficult. There is also co-operation in the preparation of materials and equipment for science lessons. A collegiality and collaboration among the teachers in implementing the curriculum clearly exists, but only during the initial implementation of the curriculum, not in the later stages.

Collaboration should be an on-going process to encourage reflective teaching in order to improve teaching. Our teachers need to be encouraged to be more articulate



about the problems they face so they do not feel so isolated. By doing so, teaching standards will improve through shared experiences, problems and difficulties.

Collaboration facilitates changes because it provides opportunities for teachers to learn both content and pedagogical knowledge from one another, encourages teachers to be risk takers in implementing new ideas, and supports and sustains the processes of individual change in science teaching (Briscoe and Peters 1997).

The syllabus itself also has a strong influence on implementation. The syllabus or the curriculum guide is the teachers' main aid to the content and strategies to be used in the classroom. In the interviews after the observed lessons, all teachers agreed that they follow the syllabus closely when teaching science even though the syllabus strategies are merely suggestions and teachers may use others. Teachers feel more secure if they use the guidelines rigidly so that they will not be blamed for not covering the syllabus. This relates to the examination culture, which insist that pupils must covered the entire syllabus in order to prepare for the exams.

The factors included in the classroom category are: pupils in the classroom, number in the class, the abilities of pupils, and the attitudes of pupils. These factors are all found to have a strong influence on implementing the curriculum. The qualitative data highlight respondents' claims that the ability of pupils plays a major role in science learning. They stated in the interviews that the science curriculum is more appropriate for high-ability pupils and that this group is able to achieve the suggested objective of the science curriculum. They further argue that weak pupils cannot achieve the objectives. The implication is that this factor is a barrier to implementing the curriculum since there will always be a class of low-ability pupils in every year of study. Teachers will have to tailor their teaching strategies to suit the pupils'

abilities, and thus they will not use all the suggested strategies with the pupils. In the views of some respondents, some of the low-ability pupils do not have adequate reading and writing ability. This slows down the learning process, as teachers have to help them with reading as well as with the manipulative processes needed to carry out the activity.

Large class sizes are also a factor that causes implementation problems. The classes of all the respondents' contain a large numbers of pupils. Teachers form six or seven groups with six or seven pupils per group. There are usually a maximum of six large working tables in the science room and most teachers use the working tables to form the group. Teachers can only provide one set of apparatus for a group of six or seven children due to insufficient materials and equipment. It was observed that only one or two pupils would manipulate the apparatus while the rest were observers and scribes. This factor is another barrier to implementing the curriculum. All pupils should be given a hands-on opportunity to gain practical skills.

The quantitative data on the influence of pupils' attitudes on implementing the curriculum are supported by the qualitative data: respondents claim that pupils are too dependent on the teacher when doing activities. One teacher's response was that pupils in Phase I have been spoon-fed, thus when they enter year 4 (Phase II) they are still heavily dependent on the teacher. There needs to be a change of attitude on pupils' styles of learning, which must start in Phase I.

This also implies a change of teaching style by all teachers. They have to encourage pupils to be more independent with the confidence to do activities on their own and enter discussion with appropriate guidance from the teacher. This could be developed through more in-service courses for teachers with a focus on lessening



pupils' dependence. In the observed lessons, pupils' attitudes toward science were very positive and showed great enthusiasm. Most pupils were eager to start the practical activities provided by teachers. Teachers should encourage this enthusiasm by providing more interesting and challenging practical activities. Pupils' positive attitudes do help in implementing the curriculum, and teachers' ability to sustain this enthusiasm should be developed. Even though pupils are the receivers of the curriculum, and it might be thought that their attitudes will have the greatest effect on successful curriculum implementation, the qualitative data indicate that this factor is of less importance than the lack of resources.

Teachers generally prefer to use dedicated science rooms despite the problems of space. The implication is that if the science rooms were spacious and well equipped, this would motivate pupils to be more interested in science. As mentioned by one respondent, the environment of the science room invites pupils to be closer to science: it is a preferred alternative to the routine of general classroom organisation of chairs and desks where they have to sit passively listening to teachers. The quantitative data show that 56% of teachers use the science room because of easy access to resources and its physical structure even when it is too small. This is another area where more resources are needed. More appropriate science rooms would also help in curriculum implementation.

Finally, the most critical factor influencing the curriculum is the teachers themselves. This includes the level of professional training, the opportunity for in-service courses, and the overall standard of teaching. These factors are considered to have a strong or very strong influence on implementing the curriculum. The data show that teachers are aware of the need for further professional training, in-service

opportunities and time to attend the courses. They are also aware of how levels of competence in teaching science affect implementation. They need more support to upgrade their professional training, thereby increasing their levels of competence in science teaching. This is supported by the interview data on teachers' backgrounds in science. A majority of teachers state that their background is not sufficient to enable them to teach science effectively. They also feel that their own science knowledge does not help them with the teaching strategies they need because the way they themselves learnt science is different from the approaches required now. There is a critical need for more science pedagogical content knowledge. A majority of teachers teaching science did not do a science option during their teacher training even though they came from the science stream in their secondary schooling. Thus most have only general pedagogical knowledge. Again, there is a need for further in-service courses to help them with the science pedagogical content knowledge required for effective science teaching.

## **6.5 The Influence of Teachers' Ideology on the Implementation of the Primary Science Curriculum**

In the context of this study, teachers' ideology includes at three domains: teachers' beliefs, attitudes and values. It is intended to discuss each of these and to compare the qualitative and quantitative data on each domain to determine the extent of its influence on the implementation of the curriculum.

### ***6.5.1 The influence of teachers' beliefs on the implementation of the primary science curriculum***

Educational researchers have long noted the importance of teachers' beliefs (See, for example, Pajares 1992, Nespor 1987). Munby (1984) observes that, if we are to



understand how a teacher might deal with an innovation, then we must first understand his/her beliefs or principles. He found that teachers' beliefs and principles are contextually significant for the implementation of innovation, be they curricular, instructional, or other.

More recent research by Haney, Czerniak and Lumpe (1996) on teachers' beliefs and intentions regarding the implementation of science education reform in Ohio, US found that teachers' beliefs are significant contributors to behavioural intention. They conclude that a top-down, teacher-proof model for science in-service experiences (one that provides teachers with all the necessary resources without attending to teachers' belief factors) is unlikely to be successful. Laplante (1997) also found that teachers are informed by their beliefs on teaching science and that their choice of teaching strategies is mediated by their views of themselves and the students as knowers in science. Brickhouse *et al.* (cited in Laplante, 1997) found that in a study of two student teachers, both had different beliefs which lead to different instructional outcome.

The above research reveals the importance of the study of teachers' beliefs in understanding the implementation of an innovation. Thus, in this study a small part of the questionnaire and interview tried to determine how teachers' beliefs affect the implementation of the primary science curriculum. The categories or the elements used were informed by the local curriculum needs. Three items were included in the questionnaire: teachers' willingness to teach science; their opinions whether science is too abstract for their pupils; and whether they agree with the promotion of science as a separate subject.

In the interviews, teachers' views were sought on their philosophy of science and how it might affect the implementation. Their views of science as a process of inquiry, their science backgrounds and other factors they thought might have some influence on the way they teach science were also sought. As the questionnaire showed that they hold strong positive beliefs on primary science, the qualitative research attempts to show how those beliefs affect the implementation of the curriculum.

The beliefs teachers hold influence their perceptions and judgements, which in turn affect their behaviour. Thus, an understanding of the belief structures of teachers is essential in order to improve their professional preparation and teaching practice (Pajares 1992). Cronin-Jones (1991) found that four major categories of beliefs influence curriculum implementation: how students learn; a teacher's role in the classroom; the ability level of students in a particular age group; and the relative importance of content topics. These categories are addressed in this study as the teachers' science pedagogical content knowledge, and our findings are in agreement with those of Cronin-Jones (1991).

Teachers adhere to different philosophies in science which are very much closely related to their basic understanding of classroom teaching. They do not discuss their philosophy of science in the context of the nature of science but instead look at it through classroom teaching. Thus, the three patterns of thinking that emerged are: that science will enhance awareness of science and technology; science will help pupils to understand the world and themselves; and science will show pupils God's supremacy. However, their main thrust to implementing the curriculum is related to their philosophy of helping pupils to understand the world and themselves and that



science is important in everyday life. These beliefs seem to originate from teachers' reading of the curriculum guide and from induction courses on the curriculum. The classroom observations also support the view that science is important for the pupils in terms of content gained through practical activities. Not many elements connecting or applying the concepts to everyday life were observed, in contradiction to the claim that science is our way of life. One respondent claimed that his teaching would instil the values that science is related to religion and maintained that he would implement science with religious value in mind. However, none of the observations was this claim substantiated. It appears that teachers' view of the implementation in terms of the religious agenda is expressed implicitly and indirectly in order to promote pupils having faith in God, i.e. through concepts related to living things and the environment. Even though teachers claim that science is important for the future of the nation, no element in their teaching actually showed this importance.

The beliefs of teachers in the idea of 'science as a process of enquiry' is another example of their simplistic view of the influence of ideas on the implementation of the curriculum. A variety of views were analysed, and for the majority this belief is synonymous with doing experiments (practical activity), i.e. without doing experiment there would not be 'science as a process of enquiry'. To others, it is synonymous with searching, experiential learning and thinking skills. However, there were respondents who argued that the idea is not applicable for all pupils. The mainstream thinking that the idea is the same as doing experiments results in the emphasis of teachers on an activity-based approach to science lessons. All the teachers observed prepared an activity-based lesson for science, but this was not

congruent with the intention of an 'inquiry process'. Instead, it was a traditional school science approach to the rediscovery of accepted concepts.

Concerning teachers' beliefs about how their science background helped them teach science, 50 % claimed it did help and 50% that it did not. The teachers who do not feel that their science background helps them teach science are mostly concerned with the pedagogy of science. The classroom observation shows that teachers have limited science content knowledge, even though 50% claim enough science background knowledge to teach the subject. What they mean is that they can transfer their own secondary school knowledge to their pupils at the primary level. Teachers need to be aware that the science content knowledge they have cannot be translated directly but must be modified through pedagogy in order to be more appropriate for their primary pupils.

The beliefs teachers have about what influences the way they teach science are mostly related to the pupils' characteristics: ability, prior knowledge and attitudes. This belief is similar to the barriers teachers feel hinder the implementation of the curriculum. Cronin-Jones (1991) also claims that implementation of a curriculum is influenced by the level of ability of pupils. Those teaching a low-ability class will not implement the curriculum as intended but will be influenced and controlled by the pupils' ability. As observed, one respondent taught a lesson without an introduction, but instead read out the steps pupils needed to carry out the activity from a workbook. Most of the time during this lesson the teacher was helping with the manipulative skills, only discussing the concept at the end of the lesson. This evidence shows that the objective of the primary science curriculum of having pupils solve problems and make decisions will not be achieved if teachers continuously use



such directed-teaching strategies. Surely, if low-ability pupils are taught to learn in a constructive way, they will also be able contribute to their own learning. The labels teachers give to their pupils also influenced their strategies, which are based on the assumption that low-ability pupils are not able to work things out for themselves.

Teachers must think differently and try to plan alternative strategies for low ability pupils, which suit their level but allow them to learn constructively (see, for example, Bianchini 1999). This means giving pupils more opportunities to express their thoughts and verbalise their meanings during the lesson. The overall view of teachers' beliefs in primary science teaching is similar to the argument of Brickhouse and Bodner (1992):

*'Teachers construct knowledge about science, their students and the science classroom that fits their experiences and meets the goal they set for themselves and their students' (p.482)*

Teachers believe that in-service courses do influence the way they teach. Thus it is critical that such courses should be prepared or programmed in order to help teachers understand the curriculum, and also the goals of the curriculum, in detail so that it can be translated to the classroom. As discussed earlier, the in-service courses are of short duration and their effectiveness in helping teachers implementing the curriculum must be questioned. The data show that the understanding teachers have of the curriculum, from the courses and presentation in the classroom, is not consistent with the curriculum objectives.

Finally, teachers state that their colleagues influence them in implementing the curriculum. Fullan (1991) argues that:

*'Significant educational change consists of changes in beliefs, teaching styles and materials, which can only come about only through a process of personal development in a social context' (p.132)*

In the context of Malaysian primary teachers, personal development in the social context only happened during the initial innovation. The reason was that during this initial implementation teachers had vague ideas about the curriculum, and there were problems of not having enough materials to help them understand how to teach science as well as a lack of equipment and apparatus. This encouraged them to discuss and share ideas on how to teach science. It is claimed that this was only done during the initial implementation and not subsequently. These initial discussions still influence their teaching. This is critical since teachers rarely change their approach even though there might be mistakes in understanding the curriculum initially. They feel that they are familiar with the curriculum and have no need for further discussion. The words chosen by teachers in explaining the support from colleagues suggest there is only a superficial collaboration. Little (cited in Fullan, 1992), considers these to be weak ties that are likely to be inconsequential. As mentioned earlier, teachers need to be reflective about their teaching, and this can be done through teachers' collegiality and collaboration in their respective schools. Moreover, it should be a continuous process as part of their professional self-development. Fullan (1991) further argues that:

*'There is no getting around the primacy of personal contact. Teachers need to participate in skill-training workshops, but they also need to have one-to one and group opportunities to receive and give help and more simply to converse about the meaning of change. Under these conditions teachers learn how to use innovation as well as to judge its desirability on more information-based grounds; they are in better position to know whether they should accept, modify or reject the change'* (p.132)

Malaysian teachers' lack of personal contact deprives them of conversation about the curriculum innovations they face.



### ***6.5.2 Teachers' attitudes toward the implementation of the primary science curriculum***

The analysis of teachers' attitudes through the quantitative data again showed that the majority of Malaysian primary teachers teaching science hold very positive attitudes towards the subject. For example, they state that they like teaching science, are confident in teaching science, and are not asked to teach science against their wishes. However they admitted that they still had to learn a lot of science and they had to get to grips with science teaching. Contra-statements included those concerning the assessment needs. A majority of teachers agree or strongly agree that it is difficult to satisfy the curriculum requirements. Even with positive attitudes towards either the science curriculum or to science teaching, this does not necessarily mean the curriculum is implemented or realised in the classroom as intended by the developers. Claiming that they are confident when teaching science contradicts their admission of having to learn a lot of science and the need to get to grips with science teaching. It may be that as trained teachers, it is unlikely that they would admit that they are not confident in teaching science, or any other subject for that matter.

The qualitative data provide a deeper understanding of teachers' attitudes towards the primary science curriculum and the teaching of science. As with the questionnaire, teachers interviewed also hold strong positive attitudes towards the curriculum. In this context the reform seems to be accepted and appreciated by the majority of teachers. The old curriculum, MAE, was not favoured since several subjects were combined, making it difficult to teach, as discussed in Chapter 1. Teachers' positive attitudes towards the curriculum are based on their understanding of the reform recommendations concerning pupils' acquisition of scientific

knowledge. Their responses are also influenced by their preference for activity-based approaches, which they believe extend pupils' interest in the subject. They also believe that the practical activity will further pupils' progress in the development of science process skills, including the thinking skills (as stated in the curriculum guide). This will eventually develop pupils' intellectual capability. For these teachers, science is the most appropriate subject to achieve this capability. The response that one teacher gave, that science enables pupils to make decisions, draw conclusion and generate ideas, was a sweeping statement since these elements were not shown in any of the observations. To some extent the responses given show a discrepancy with the classroom observations. In this context, it seems that teachers verbally repeated the reform recommendations but have not internalised them and are not able to implement the intentions of the designed curriculum. Harlen and Jelly (1997) suggest that for children to learn science with understanding, teachers must understand that children learn science by making their own sense of their experiences, linking new experiences to existing ideas and past experience, and changing ideas to fit the evidence (p. 27). They further suggest that children's learning experiences to gain understanding should be conducted by actively seeking evidence through their senses, checking ideas against this evidence, and taking account of others' ideas to seek more effective ways of testing. They also suggest that the role of the teacher is to find out children's existing ideas and help children to test predictions based on them; to help children devise and reflect upon ways of testing predictions fairly and to promote interaction with materials and others' ideas. The role of the children is to become involved in raising questions, discussing ideas and making predictions and proposing ways of testing them. In Malaysia these



suggestions would enable teachers to understand how science teaching can support pupils' development in terms of generating ideas, making decisions and drawing conclusions. The elements suggested by Harlen and Jelly (1997) were not encountered in any of the classrooms during the observations. Teachers must provide opportunities for pupils to discuss their ideas, and to help them clarify the meaning of words used, modify ideas through sharing, and also link ideas from context to another.

Generally, teachers state that the introduction of the new curriculum was long overdue. They recognised a need for a separate curriculum instead of the MAE, so there is no reason to worry that teachers will not implement the new curriculum. The fundamental question is whether the curriculum is realised in the classroom. The centralised education system with the embedded culture of following instructions and legislation does not develop teachers who evaluate their own performance, question, discuss or debate the legislation presented to them. There should be opportunities for this during the introductory stages of the innovation, long before it is implemented, so that teachers can gain confidence in the curriculum and implement it as intended.

Although, there are negative views on the implementation of the new curriculum (discussed in Chapter 5) there are fewer negative attitudes towards this curriculum itself. One respondent was concerned about pupils' lack of prior knowledge due to lack of facilities and the environment. The curriculum developers do not have first-hand experience of schools in deprived areas or of rural schools. The needs of pupils from such environments have been overlooked. As one respondent mentioned, rural school pupils lack prior knowledge (due to their background of poverty), and facilities such as

science reference books and other support for children's learning are not available due to parents' low academic ability and poverty. This was evident in the observation of the rural schools. For example, one respondent state that the school is an area surrounded by rice fields and children really love to watch the machines harvesting the rice since they have no other experiences of modern science and technology at home. Another respondent claimed that the standard of the primary science curriculum is too high and is also taught in the secondary school, and so she wanted the scope to be reduced. An analysis of the secondary science curriculum (Ministry of Education 1988) shows that the syllabus is an extension of its primary counterpart. The primary science syllabus has five fields of investigation (for a translation of the syllabus, see Appendix 11)

- a) investigating the living world
- b) investigating the physical world
- c) investigating the material world
- d) investigating earth and the universe
- e) investigating technological world

Whereas in the secondary school, the syllabus is designed to include four main themes:

- A. Man and the variety of living things around us
- B. Earth's rich resources and its management
- C. Energy for our life
- D. Man and equilibrium in the universe

It can be seen from these two syllabuses that the field 'investigating the living world' (a) is the introduction to the theme 'man and the variety of living things around us' (A). At the secondary level this theme is approached in more detail, including a variety of living things, human senses, co-ordination in the human body, reproduction and growth, human variation and micro-organisms and their effects on



humans. The primary syllabus of the living world only contains a basic knowledge of plants and animals, their attributes and characteristics, the survival of species and the interaction of living things. The arguments of the respondent about the syllabus reflect her ignorance of the depth of the secondary school science curriculum. There are different levels within the same field/theme for the primary and secondary levels. The understanding of the objectives and goals of science teaching at the primary level must be clarified for the primary teachers.

The problem is not the syllabus but understanding it and its pedagogical implications. Comparing the primary and secondary syllabuses, it can be seen that the primary level is compatible with pupils' cognitive growth, and saying that it should be reduced reflects teachers' pedagogical knowledge of science and science teaching. The short in-service courses cannot provide for teacher development in this area. For a curriculum innovation to be successfully implemented, teachers need to change their attitudes and beliefs in accordance with the innovation.

Teachers can collectively influence the curriculum. One respondent stated that science should be introduced earlier in Year 1 as science across the curriculum, and should include all teachers. Prior to the introduction of The National Curriculum of England and Wales (cited in Emmerson and Goddard 1989) *The National*

*Curriculum 5-16: A Consultation Document* states:

*'.....there are a number of subjects or themes such as health education and use of information technology, which can be taught through other subjects.....It is proposed that such subjects or themes should be taught through the foundation subjects, so that they can accommodate within the curriculum but without crowding out the essential subjects.'* (p.20)

This was an attempt to include cross-curricular themes in the National Curriculum.

Bentley (1993) discusses the example of cross-curricular elements of science in

other subjects such as environmental education and health education. Bentley (1993) shows that health education is linked to attitudes, self-esteem, skills and knowledge, and provides a context for teaching science in which scientific knowledge can be used to make decisions which will be crucial to children at various points in their lives. He further suggests that contextualising scientific concepts within a health example, is essential if children are to have the opportunity to practice decision-making. Therefore, in England the problem of cross-curricular themes is addressed by the programmes of study for each Key Stage which make connections between science and other subjects. For example (cited in Bentley, 1993) in environmental education

#### Key stage 1

*'.....(pupils) should be given the opportunity to study how science is applied in a variety of contexts....They should consider the advantages and drawbacks of applying scientific and technological ideas to themselves, industry, the environment and the community. They should begin to make personal decisions and judgements based upon their scientific knowledge of issues concerning personal health and well being, safety and care of the environment.'*

This implies that the cross-curricular theme will help pupils not only to understand science but also to use scientific knowledge in other aspects of their lives. As stated in the module developed by the CDC (1993a), on the strategy of integrating science elements in the teaching and learning of the Malay language, Chinese, Tamil and

#### Mathematics in Phase I:

*' The teaching and learning process of Languages and Mathematics would be more interesting when science elements are integrated. This is due to the objects and the phenomena that are happening in the pupils' surrounding. Pupils are always stimulated by the objects and phenomena. Therefore learning about these, would at least fulfil pupils' curiosity' (p.2)*

However, in the interviews, it was found that not all respondents were aware of such integration of science elements during Phase I in languages and mathematics as



suggested by the CDC. The problems of integrating science elements in Phase I are not being monitored and are generally ignored by Phase I teachers. It is the role of the District Education Officer to implement this integration because collectively teachers are able to influence the curriculum. If Phase I teachers take science elements into consideration in their teaching of other subjects, this would help the Phase II teachers to take forward conceptual development in science. This is another example of how teachers' collegiality and collaboration within the schools can influence the curriculum.

Another concern of teachers is pupils' difficulty in developing science concepts. One teacher claimed that pupils do not understand the concepts, without reflecting on how this understanding might be achieved. It was observed that pupils are asked to answer prepared questions and if the answers are correct, it is assumed that they understand the concept. However, some teachers dictated the answer to the pupils and at other times pupils copied the answer from their friends. Then, during discussion the teacher asked the questions again and asked specific pupils and assumed that one pupil's correct answer indicated general understanding.

Understanding children's conceptual development is important for teachers if they believe that this criterion is their most important priority in science education. As Willig (1990) states:

*'Essentially, knowing the level of children's present abilities helps to determine the shape of future learning experiences. More specifically, a knowledge of conceptual development underpins the techniques of matching teaching material to the ability of the learner, disturbing the learner's existing ideas, learning by telling, learning from observation and thinking about thinking.'* (p.13)

As mentioned earlier, the strategies and teaching materials used in the lessons did not always match the learners' need and this might explain that pupils do not always

understand the concepts being taught. It was observed that teachers do not take account of individual differences. Harlen (cited in Willig, 1990) defined the concept of matching as:

*'finding out what children can already do and what ideas they have, as a basis for providing experiences which will develop these skills and concepts. The keynote of matching is thus finding the right challenge for a child, the size of step that he can take by using but also extending existing idea.'* (p.184)

This provides an insight into the importance of the concepts that children have acquired informally, and which need to be taken into account by teachers. As has been discussed in Chapter 5, the teachers, generally, do not use children's prior knowledge when providing experiences, but instead have a pre-structured experience for pupils to carry out in the lesson. Such planning matches teachers' lesson objectives but does not consider matching the material to the learners. What the teachers did resembled traditional school science, which all too often led from a contrived context to a predetermined solution.

Shayer and Adey's (1986) work on the proportion of children at different Piagetian stages in a representative sample of the British child population at the age of 10 years shows that 35% are at or above the stage of late concrete operations, 40% at the age of 11 and 55% at 12 years. However, in the Malaysian context, the children only start formal science learning in our primary schools at the age of 10, entering secondary school at 13. Therefore, their cognitive development may or may not be the same as in Shayer and Adey's population. However, the research shows that in formulating a curriculum, developers must take account of the cognitive development of children. In Malaysia the cognitive development of pupils has been considered, and the children at this age (10-12 years) must be between the early concrete stage and the late concrete stage. Teachers must also bear this in mind when planning for science.



The mismatch observed in the lessons is not between the curriculum and the pupils, but it is between teachers' strategies and the abilities of the learners. This implies that teachers' science pedagogical knowledge needs to be enhanced. As Willig (1990) states:

*'... .., we turn to strategies designed to extend children's thinking in various ways: by provoking a cognitive conflict; by structuring meaningful reception learning; by encouraging observation; by promoting self-monitoring and control of one's own cognitive processes-all of which are based on the principle of matching the learner's level of ability to the new material'(p.23)*

Shayer and Adey's (1986) work showed that there has been a mismatch between the cognitive development level of secondary school pupils in science and the science curricula. They highlight teachers' cultural emphasis on 'labelling' pupils and state that this leads teachers to take actions which are self-fulfilling (p.140). This implies that teachers assume pupils within a group have the same cognitive level and teach pupils accordingly. As Shayer and Adey (1986) observes:

*'Our view is that by understanding the difficulties of different learners, and taking that understanding into your thinking about lesson planning you not only show respect for them as persons, but also very much increase the rate at which they are able to learn and the breadth of knowledge and skills that they can achieve'. (p.140)*

This is the aim towards which Malaysian teachers should strive, with appropriate help and support through in-service training.

Nevertheless, both the qualitative and quantitative data show that a majority of teachers like teaching science despite the weaknesses mentioned. This was also the case in England. Wrag *et al.* (1989), in their survey examining teachers' attitudes towards the National Curriculum, found that only 33% of the teachers questioned felt competent about their ability to teach science. Widespread anxiety was reported among the remainder about their lack of knowledge in basic science. The findings of Kruger, Summers and Palacio (1990) support the views that teachers actually have

positive attitudes towards science teaching. They found that teachers recognise the inconsistencies and inadequacies in their understanding but they exhibit an interest and motivation in improving their performance in developing better knowledge and understanding of the concepts. Carre and Carter (1990) found in their study that while many teachers rate themselves competent in helping children achieve statements of attainment and science process skills, a disturbingly large number indicate they need a good deal of in-service support (p.339). OFSTED, during the academic year 1993-94 found that:

*18. The quality of science teaching in Key Stage 2 was slightly less satisfactory overall than in Key Stage 1. Sixty nine percent of the lessons were judged at least satisfactory and 27% good or very good*

*19. Preparation is mostly good and teachers employ a suitable range of methods, including demonstration, clear exposition as well as practical work of various types. Investigative activities (Sc1) are, however, often less well linked with the development of knowledge and understanding than in Key Stage 1 and opportunities for pupil investigation are fewer. Over-direction is a weakness of many of the poorer lessons. In the upper years of the key stage, shortcomings in teachers' understanding of science are evident in the incorrect use of terminology and an overemphasis on the acquisition of knowledge at the expense of conceptual development. Pupils are at widely different stages in their development by the end of the Key stage. Planning at both class and whole school level does not take sufficient account of this. (p.10)*

Even though Kruger *et al.* (ibid.) demonstrated the importance of the INSET, which was increased, the findings by OFSTED implies that even more INSET needs to be provided. This is confirmed by the OFSTED report of 1992-93 that the INSET for Key Stage 2 was inadequate:

*62. Training opportunities for the Key Stage 2 teachers have been fewer than those provided when the Key Stage 1 was introduced. This, combined with limited time for discussion within the schools, has contributed to a relative lack of expertise and knowledge of the National Curriculum shown by the teachers in Key Stage 2, compared with those in Key Stage 1. (p. 24)*



The lack of in-service training seems to be the most fundamental problem in both England and Malaysia, and more help must be given to teachers so that effective implementation will occur.

Gabel and Rubba (1979) found that one method of changing primary teachers' attitude toward science teaching is through participation in workshops on new science curricula, that attitudes are developed over a long period of time, and that persistent changes cannot be made through short-term programmes. This implies that short in-service courses, as have been provided in Malaysia, are not adequate to support attitude changes.

### ***6.5.3 Teachers' values in implementing the primary science curriculum***

In this study, teachers' values are looked at in the context of teachers' opinions on children learning science through practical activities and on whether science helps meet individual needs. Data were gathered from the questionnaire responses. A detailed understanding of teachers' values towards science teaching was investigated further through the qualitative data. Teachers were asked their opinions on how they would view a good science lesson, the most important pupil outcomes in science, and the best ways of educating pupils through science.

The quantitative data on the two statements to elicit teachers' values in relation to the primary science curriculum (children learning science through practical activities and science helping in meeting individual needs) showed some contradictions. A majority of teachers believe that children learn science through practical activities, but ironically they also agree that science does not help meet individual needs. This contradiction highlights the vagueness in realising the curriculum at classroom level.

The qualitative data give a more detailed meaning to the values teachers hold in implementing the primary science curriculum. Again, a majority thinks that a practical (experimenting) approach is the best way to teach science, including the science process skills listed in the curriculum guide. The qualitative data also show that, in terms of classroom organisation, teachers believe in organising the class as a mixed ability group. This opinion is related to their view of the value of practical activity for children learning science. Mixed-ability grouping for practical activity is supported by research done on grouping children for effective learning. Howe (1990) found that children's progress is more advanced when they are put in a group where the level of understanding varies.

Another value concerns feedback from the pupils in science lessons. Teachers agree that a question-answer session at the end of the lesson, written exercises and tests are the best ways to evaluate teaching outcomes, with only a minority mentioning feedback during an activity while learning is in progress. However, no teacher mentioned that assessment would be used to inform planning. The methods teachers use to get feedback on pupils understanding is very much similar to the exam format that tests pupils' knowledge on science content. The classroom observation show that the worksheet teachers gave contains questions on process skills, and also questions testing content knowledge. The questions-answers sessions at the end of the lessons are very much content-oriented. According to Ritchie (1997), planning for science in the classroom should be informed by teachers' identification of children's learning needs, and the children's needs need to be identified through previous assessments of earlier work. As Foden (1993) states:

*'It is equally important to ensure that assessment is not a bolt-on addition at the end of a period time or learning package. It needs to be planned into children's*



*experiences and be an integral part of what we teach, as teachers, do each day with children.* ' (p. 153)

Teachers need training in using assessment as an integral part in their teaching. The evidence should be gathered through what pupils do, produce and say, and teachers must listen actively to pupils and must ask focused questions (Ritchie 1997). It seems that Malaysian teachers do not use assessment evidence because the planning of the lesson is very much influenced by the curriculum guide, and they plan for a whole year and seem unable to adapt their plans and learning outcomes according to ongoing assessment evidence. Teachers must have lesson objectives, which include getting information from pupils in order to plan their next lesson. In general, the analysis of the teachers' values relating to the science curriculum shows that they mostly try to conform to the curriculum guide. A majority of teachers try to achieve the objectives of gaining science concepts and facts as a high priority due to examination constraints. There is no science across the curriculum in Phase I. This gap needs to be taken seriously in order to improve pupils' science understanding and learning at an earlier stage. In the National Curriculum for England and Wales, for example, science has been incorporated in the curriculum as early as Key Stage 1, where the pupils' ages range from 5-7, whereas in the Malaysian curriculum science is only taught formally to 10 to 12 year-old pupils.

## **Conclusion**

The above discussions on teachers' understanding of the curriculum and its implementation reveal that teachers mostly need help and support in implementing the curriculum. In this context, the discussion has revealed that this group of teachers (interviewed and observed) who worked in schools in the rural areas face many problems in trying to implement the curriculum. The current in-service education

and training in Malaysia has proved to be inadequate in supporting teachers' professional development in science education. Therefore the design of the INSET need to be carefully planned in order for the activities provided to have a maximum effect.

Harland and Kinder (1997) studies on a programme of staff development concerned with science in primary school has revealed nine outcomes; material and provisionary outcomes, informational outcomes, new awareness, value congruence outcomes, affective outcomes, motivational and attitudinal outcomes, knowledge and skills, institutional outcomes and impact on practice. They developed a tentative sequence or hierarchy of the outcomes. 1<sup>st</sup> order - value congruence and knowledge and skills. 2<sup>nd</sup> order – motivation, affective and institutional. 3<sup>rd</sup> order - provisionary, information and new awareness. In their tentative conclusion, they maintain that in order to maximise the chances of in-service education and training leading to a change in classroom practice, all the nine 'outcomes' (prioritised in the order suggested) need to be present as pre-existing conditions or be achieved by the INSET activities.

This implies that in the Malaysian context, the in-service training provided for the teachers need to consider and give more focus on the 1<sup>st</sup> and 2<sup>nd</sup> order outcomes to give more impact on practice or changes in practice. The present method of in-service suggests that only the 3<sup>rd</sup> order of outcomes is being focused. Harland and Kinder (1997) found that the evidence of the evaluation of continuous professional development which focus on 3<sup>rd</sup> order outcomes are least likely to impact on practice unless other higher order outcomes are also achieved or already exist.



In the Malaysian context the in-service outcomes that teachers gain are mainly the informational and new awareness outcome. The informational outcome is mainly gained by being briefed of background facts and news about the curriculum and its implication for practice. This is reflected in the teachers' responses on their beliefs in primary science education. The teachers' responses showed that they conformed to the information given about the new curriculum. Thus they believe that science is important for children for future life and that they claim they implement the curriculum with this awareness. The new awareness outcome is gained when teachers shift their previous perceptual or conceptual assumptions of which constitutes the appropriate content and delivery of the primary science curriculum. The evident from the interviews clearly show that the teachers' claim that they are most helped with the new teaching strategies which include the science process skills. They also maintained that science as a process of inquiry is good and applicable in science teaching. Similarly their responses on what constitute a good science lesson, they maintained that an inquiry approach as the best approach in science teaching. However, the classroom observations showed that this did not materialise in the classroom. This indicates that even though these teachers assert that they have changed awareness but there is no guarantee of changed practice as the classroom observation showed.

Peacock (1998) argues that for teachers to evaluate their professional development is through competence criteria and that when teachers are given the responsibility to develop this criteria they generate trust and confidence and this leads to supportive critical analysis on the teachers part. Peacock (ibid.) further argues that professional development programme need to be phased and explicitly matched to the varying

levels of development of participants. The discussions in sections 6.3.1, 6.3.2 and 6.3.3 show that teachers do not have specific criteria to evaluate their competence and performance in implementing the curriculum. Their evaluation of their performance is only reflected in their responses on the difficulties they face in implementing the curriculum, which is mostly caused by their pupils' ability, attitude and background. Peacock (ibid.) maintain that teachers have to be permitted to generate and therefore own those competencies which are relevant to their distinctive cultural/pedagogical context and this will give teachers the opportunity to participate in the stages which are necessary for their professional development. The interview data indicate that teachers do not evaluate their lessons according to their competence but only through their pupil's performance and difficulties caused by their pupils and resources. Peacock's (1998) mentioned that one of the outcome of the teacher development process is that:

*'Teachers also become aware in practice of the need to establish levels of achievement in any given skill area in order to evaluate progress and set targets (Hatton & Smith 1995). It was apparent that professional development programmes need to be phased and explicitly matched to the varying levels of development of participants'. (pg. 155)*

Therefore in the context of the in-service provider for the Malaysian primary science teachers need to consider a program which will give more emphasis for the process of teachers development to become effective evaluators of their own teaching competence in science. It is hope that with the professional skills indicator they developed themselves, they will be able to evaluate their lessons. However, as suggested by Peacock (ibid.) the program need to be phased as it takes time and relies on the development of teachers' confidence.

Similarly, Harvey (1999) proposes that the instructional goals in INSET should vary according to the existing 'stage of development' of teachers. The experience he has



with the INSET of the Primary Science Programme in South Africa has shown that more attention need to be given to develop models of teachers' professional learning which must be appropriate to each stage of development.

Therefore, this suggests that the in-service for the Malaysian primary science teachers need to be designed in such a way that it will focus on teachers need.

Teachers need time and support to discuss the science pedagogical content knowledge which the findings has shown that these teachers lack. As the above authors have proposed, the models of the in-service programme need to be phased.

Teachers need time to progress from one phase to the next. Harvey (1999) states:

*'In the light of these stage-specific goals, part of the challenge of designing INSET rest in developing the capacity to diagnose teachers' stage of development, and adapt the INSET curriculum appropriately' (pg.608)*

## **Chapter 7 CONCLUSION AND RECOMMENDATIONS**

### **7.1 Introduction**

This study was undertaken with a view to understanding teachers' perceptions of the Malaysian primary science curriculum and, especially, to considering how teachers' pedagogical content knowledge helps or hinders them to implement the curriculum. Therefore, the main reason for the study was not so much to determine the success or failure of the curriculum implementation but rather to look into the problems teachers have at classroom level in implementing the curriculum. Previous research done in Malaysia on other curriculum innovations and implementations by Siti Hawa (1986), Azizah (1987), NoorAzmi (1988), Zainal (1989), Sharifah Maimunah (1990) has revealed major problem and a lack of in-service courses to help teachers. This study was undertaken, in the main, to determine teachers' own opinions and views on the implementation of the primary science curriculum. A combination methodology was applied to get a wider picture of the implementation at classroom level. The quantitative research aimed to give a broad view of the implementation, and the qualitative research sought to provide a closer examination of the implementation through a case study of 14 teachers' perceptions of the implementation at classroom level. This chapter will reiterate the conclusions derived from the findings. There is no attempt to generalise the findings nation-wide, since that would need a more elaborate study. The main aim is to draw attention to teachers' science pedagogical content knowledge and ideology as they implement the curriculum. It is also essential to draw attention to some of the difficulties encountered. Some observations and issues arising from the study will be discussed. Finally, implications will be drawn in order that recommendations for the future



teacher education programme and teacher development programme can be made for more effective science teaching for primary school children.

## **7.2 Teachers' Perceptions of the Primary Science Curriculum**

The previous chapter discussed the findings of the teachers' curricular expertise in the context of the implementation of the Malaysian primary science curriculum. The findings can be summarised as follows. Teachers find the important objectives of primary science education difficult to implement. On closer examination, an understanding of the objectives requires teachers to use their science pedagogical knowledge. As most of the respondents to both the qualitative and quantitative surveys have no or only limited science backgrounds, a general lack of science pedagogical content knowledge was observed to hinder them from implementing the curriculum as intended. This suggests that when a new programme is introduced, teachers need an in-depth understanding of the rationale of the new curriculum and what is expected of them in translating the curriculum with practice. Before teachers can implement the curriculum, the key objectives need to be scrutinised by teachers in order to understand the whole curriculum. The findings highlight teachers' inability to implement those important objectives of the curriculum related to teachers' science pedagogical content knowledge.

There are several factors that contribute to teachers' lack of science pedagogical content knowledge. First, the teaching approach used in science classes shows a discrepancy between teachers' aspirations for their classroom practice and the observed patterns of classroom interaction, and this affects the implementation of the curriculum as intended by the developers. Secondly, the investigation of teachers' views on pupils' science learning shows that teachers' desired outcomes

for pupils are very much influenced by the exam culture in Malaysia, thus depriving pupils of other important outcomes of science learning. Thirdly, the roles teachers adopt in their classroom teaching also show a discrepancy from the intended roles. Teachers' science pedagogical content knowledge, at present, is not sufficient to help them implement the curriculum as intended. Fourthly, the barriers that teachers face in implementing the curriculum are mostly due to lack of resources, pupils' backgrounds and characteristics, and class sizes. Finally, in researching teachers' ideology, which includes their attitudes, beliefs and values, the overall picture from the data was one in which many teachers rate themselves as competent in teaching science. They have positive opinions on, and interests in, teaching science, but a disturbingly large number indicate that they need support from the in-service programmes. This ideology also influences the implementation of the curriculum. Teacher development requires a programme that will change teachers' ideology in relation to science teaching and learning, especially their beliefs.

### **7.3 Issues and Observations arising from the Study**

Many issues emerge from the study. Even though it was taught for eleven years as a component of MAE, Primary Science has, until now, not been a main subject in the primary curriculum; its inclusion has generally been welcomed by teachers.

However, when the implementation was announced in December 1994, teachers and schools were not ready physically or pedagogically. Science education throughout the world has undergone tremendous changes over the past 20 years, and many countries are now moving towards a constructivist approach. Unfortunately, most teachers in Malaysian primary schools are products of a more traditional science



background, where the transmission of knowledge conditions teachers' beliefs and perceptions of the nature of the subject.

The new Malaysian primary science curriculum is based on a constructivist approach. However, as the study shows, teachers do not have a clear understanding and knowledge of the pedagogy, which needs to be understood by teachers experiencing it themselves, as suggested by Watts (1998), Appleton and Asoko (1996) and Stofflett (1994). Therefore, even though there is a world-wide change in approach to school science learning based on constructivism, the Malaysian primary science teachers need further progressive training in the constructivist approach as a new reform in the science pedagogy. This should be more than just 'lip service' if we care for effective science teaching by our teachers. When teachers do not have a clear understanding of an approach, most of them do not use it in class, or, if they do, it is with uncertainty and is modified according to their understanding and experience.

A further confusion exists because the teacher training colleges are producing newly qualified teachers with a constructivist science pedagogy, but when they are placed in more 'traditional' schools, they experience a tension between old and new teaching methods. The assessment of student teachers during their teaching practices, at present, is 70% by school mentors and only 30% by college lecturers (Ratnavadivel 1999). This raises significant issues concerning the validity of the mentors' assessment, as this study has revealed teachers' lack of understanding towards the constructivist approach. Even though the colleges train teachers in mentoring skills, they are generic rather than subject-specific skills for science pedagogical knowledge. The implication here is that the practising teachers will

advise the trainees towards traditional science teaching as they themselves practice it, and this will influence the trainees to move towards the conventional style of teaching, i.e. the transmission of knowledge approach. Teachers are not ready to use the constructivist approach per se even though the CDC produced a module (Module 12) on this in 1996. The dissemination of the module does not appear to have been effective.

KBSR science also emphasises science process skills. In the Malaysian context, using the science process skills (as stated in Module 3 by CDC 1994c) enhances the thinking skills. Thus, teachers attach great importance to thinking and science process skills. Teachers also maintain that science content is important. This implies that teachers generally understand the balance between process and content in children's science learning. This seems to support Swatton's (cited in Warwick and Linfield, 2000) argument that teachers generally adopt an 'holistic' view, with a strong organic relationship between process and content in children's learning. This means that both content and process skills require teachers' careful attention and knowledge to integrate them during teaching so that development in both aspects is gained by children. As Harlen (1998) points out:

*'However, science process skills cannot be used and developed unless children are working on appropriate content, that is, content that is relevant, amenable to scientific investigation and within their grasp to understand at a meaningful level. Conversely, using and developing process skills — thinking skills as well as 'doing' skills — enables children with understanding. True conceptual development cannot take place if children are not engaged in doing their own thinking' (p.28)*

It is evident that the Malaysian primary science teachers appreciate the interaction of processes and concepts in children's learning science. However, as the study shows, teachers lack science pedagogical knowledge, and therefore they face problems in developing this two-way interdependence to determine the achievement in pupils



understanding of the world around them and the scientific method to support that understanding.

Another key issue is the lack of resources for science teaching in terms of materials and apparatus or equipment. Monk and Dillon (1993) reported that common problems in teaching science by teachers in developing countries are commonly due to lack of equipment, overcrowded syllabuses, out-of-date textbooks and examinations that concentrate almost exclusively on recall. Malaysia is not exceptional in the matter of lack of resources. As the concept of science learning through pupils' active participation in activities gains strength, the need for materials and apparatus becomes acute. Without the opportunity for students to do their own investigating, their experiences are restricted (Driver 1983). Teachers' understanding of the importance of activity-based learning with practical activities or investigation in science learning has resulted in them planning most lessons with this in mind, despite the lack of apparatus and large classes. This obviously does not help pupils' construction of meaning and understand science when only a few pupils are able to handle apparatus and be engaged in practical work.

It could be argued that the innovations in the primary science curriculum have been interpreted in an oversimplified way. The teachers have not demonstrated an in-depth understanding of the curriculum, caused mainly by the lack of science pedagogical content knowledge and their own ideologies. Teachers need more clarification of what the curriculum guide actually means. For example the actual meaning of the 'guided inquiry approach', the 'constructivist approach' or even the meaning of the role of facilitator in the context of science teaching and learning need to be explained in more depth. This will help teachers to plan and use the correct

strategy for effective science teaching. The curriculum developers need to understand that teachers require a simple and straightforward language directed towards practical classroom problems.

## **7.4 Implications and Recommendations**

### **7.4.1 Science Teacher Education**

Even though this study has focused on practising teachers' teaching of primary science, the findings also allow suggestions to be made for the improvement of the primary science education in the teacher education programme.

The study has shown that teachers' preconceptions of science teaching have the greatest influence on their teaching behaviour in their science classrooms. These preconceptions are seen to influence not only their understanding of science knowledge, but also their values, beliefs and attitudes about science and the teaching and learning of science.

In Malaysia's teacher education programme, the components taught include knowledge of science (subject matter), science teaching methods, and other related knowledge concerning management, classroom organisation and resources. In Mellado's (1998) terminology, this is known as the 'static component'. However, this knowledge is insufficient for prospective teachers to change their beliefs and raise the matter of science teaching practices. Trainees must also undergo the 'dynamic component' which comprises the static component plus self-knowledge, personal reflection and other related elements of teaching practice. Although the importance of the dynamic component is undeniable, teacher education programmes rarely address this issue in-depth (Mellado 1998). Since teachers' preconceptions are



seen to influence their behaviour, it would be beneficial to focus on the dynamic components so that teacher educators would be able to help prospective teachers to review those preconceptions, including their beliefs, values and attitudes towards science teaching and learning.

The implication here is that the science teacher training programmes should consider the inclusion of an element where prospective teachers would be able to express and explicate their preconceptions and which would encourage critical self-reflection.

The prospective teachers should be helped to become reflective and self-conscious about their beliefs and this could help to change their behaviour. This should be done both during teaching practice and also during the taught elements of their course.

Teacher educators need to focus more directly on identifying existing teacher beliefs, and stimulating trainees to examine and change their beliefs about issues such as how students learn and the teachers' role in the classroom. Prospective teachers need to be encouraged to make such inquiry a habit that will serve them well throughout their careers.

As the model for teaching primary science is constructivist — a model based on a conceptual change learning strategy — it is essential that instruction for prospective science teachers uses the same model.

#### ***7.4.2 Science teachers' professional development programmes***

Results from the study suggest some challenges for the designers of the in-service programmes. The usual method of disseminating an innovation has proved ineffective; therefore a different method must be introduced for a more effective implementation of an innovation. Ariza and Gomez (1992) found that there was a

distinct change in teachers' pre-conceptions when the in-service teacher education strategy adopted a conceptual change teaching programme. This was also useful in exploring teachers' concepts about science, how to teach science and how pupils learn science. Similarly, Haney, Czerniak and Lumpe (1996) also suggest that conceptual change models of staff development may help to accommodate teachers' attitudes towards implementing the strands, which are critical components in the educational change process.

This study has shown that teachers' classroom practice is informed by their preconceptions and understanding of teaching and learning of science and its objectives. These preconceptions and understandings coalesce into teachers' perceptions. Any proposed innovation has, consequently, to be congruent with these perceptions if it is to be acceptable to teachers. The present study clearly shows that teachers' perspectives and understandings are incompatible with the central values of science teaching. This is disturbing indeed for it questions the appropriateness of the intended primary science education in a Malaysian context.

However, if significant innovation is to be achieved, teachers' concerns must be recognised. Their problems should be acknowledged and viewpoints taken seriously. Therefore, teacher development and change has to start from exploring and evaluating teachers' current practices and beliefs, and has to take account of their concerns about their own professionalism and feelings of self-worth. Reform or innovation in the science primary classroom must be based on knowledge of teachers' actual practice and an understanding of, and support for, the environments in which primary teachers work.



Teachers need to work collaboratively so that they can bring their shared experiences and problems and discuss these with experts, thereby developing their understanding of science education. The confidence derived from this approach would help teachers in their respective classrooms and they would be able to generate new personal views towards science teaching. They could also be encouraged to reflect on their teaching through action research, with regular seminars based on this approach. All of this needs to be monitored, and consultation and reinforcement needs to be ongoing if effective curriculum implementation is to be achieved. The most important strategy in implementing a new intended curriculum is for teachers to be given an in-depth exposure and understanding of the rationale and theoretical perspectives underpinning the curriculum. Teachers would then not only understand, but also internalise, the objectives and the instructional strategies, and they will be able not only to implement it but also sustain the curriculum innovation.

**SECTION 1.**

**This part of the questionnaire is about you and your background in science.**  
***Please answer the question by putting a tick (✓) in the appropriate box.***

1. Sex    Male ☐    Female ☐

2. Age   20-25 ☐   26-30 ☐   31-35 ☐   36-40 ☐   41-45 ☐   >46 ☐

3. What is your highest qualification?  
Lower Certificate of Education /SRP ☐    Malaysian Certificate of Education/SPM ☐  
Higher School Certificate /STPM ☐    Diploma ☐

*(if others, please specify.....)*

4. How long have you been teaching?

Less than a year ☐   1-5 years ☐   6-10 years ☐   11-20 years ☐   more than 20 years ☐

5. How long have you been teaching science?

Less than a year ☐   1 year ☐   2 years ☐   3 years ☐   >4 years ☐

6. What were your option/major during teacher training?

Science ☐   Non- Science ☐

*(If non-science, please specify.....)*

7. What other subject(s) do you teach besides science at present ?

*(Please ✓ at the appropriate boxes, you may tick more than one)*

Bahasa Malaysia ☐   Music ☐   Moral ☐   Art ☐   Physical Education ☐  
English ☐   Mathematics ☐   Local Studies ☐   Living Skills ☐  
Islamic Religious Education ☐

8. Which level of pupil do you teach science to at present?

*(Please ✓ at the appropriate boxes)*

Year 4 ☐   Year 5 ☐   Year 6 ☐

9a. Have you attended any in-service courses for primary science education?    YES / NO

*(Please circle the appropriate answer)*

9b. If you answer yes, please state the following

Name of the Course	When (Year)	Duration (No. of days)
i.		
ii.		
iii.		



**SECTION 2.**

**This part of the questionnaire is about the objectives of the primary science curriculum.**

In this part of the questionnaire you will be able to give your opinion and views on the objectives of primary science education. What are your thoughts about them and implementing them. Always bear in mind **THE CHILDREN'S BACKGROUND AND ABILITIES IN YOUR SCIENCE CLASSROOM** when giving your views in this section.

10. Below is a list of primary science objectives as stated in the primary science curriculum document. Based on your experience teaching KBSR science, what is your opinion of the importance of each of the objective. Study the list and evaluate the importance of each objective as you implement it in your class.

*(Please use the scale below for statements i -ix below*

Extremely important =5, Very important = 4 , Not Sure = 3, Not very important=2, No importance=1

The objectives of primary science education are to give pupils the opportunity to:

- |  |                                     |
|--|-------------------------------------|
| i. develop thinking skills to increase intellectual capability   | <input checked="" type="checkbox"/> |
| ii. increase interest in the environment   | <input type="checkbox"/>            |
| iii. develop scientific skills, attitudes and an inquiring manner  | <input type="checkbox"/>            |
| iv appreciate the orderliness of the universe  | <input type="checkbox"/>            |
| v. gain knowledge and understanding of the scientific concepts and facts in order to understand themselves and their environment | <input type="checkbox"/>            |
| vi. develop the ability to solve problems and make responsible decisions   | <input type="checkbox"/>            |
| vii. increase their ability to cope with the latest contributions and innovations in science and technology                      | <input type="checkbox"/>            |
| viii. practice good moral values and scientific attitudes in every day life  | <input type="checkbox"/>            |
| ix. appreciate the contributions of science and technology for the welfare of man  | <input type="checkbox"/>            |

11. Based on the primary science objectives as in question 10, please Rank the objectives **IN ORDER OF IMPORTANCE**.

*Please indicate which you consider are:*

*a) the two most important of the objectives by putting 1=most important, 2= second most important*

*b) the two most least important of the objectives by putting 3= least important, 4 most least important*

**PLEASE ENSURE THAT YOU HAVE GIVEN ONLY TWO MOST IMPORTANT AND TWO LEAST IMPORTANT**

The objectives of primary science education are to give pupils the opportunity to:

- |  |                          |
|--|--------------------------|
| i. develop thinking skills to increase intellectual capability   | <input type="checkbox"/> |
| ii. increase natural interest in the environment   | <input type="checkbox"/> |
| iii. develop scientific skills and attitudes in an inquiring manner  | <input type="checkbox"/> |
| iv appreciate the systematic structures of the universe  | <input type="checkbox"/> |
| v. gain knowledge and understanding of the scientific concepts and facts in order to understand themselves and their environment | <input type="checkbox"/> |
| vi. develop the ability to solve problems and make responsible decisions   | <input type="checkbox"/> |
| vii. increase their ability to cope with the latest contributions and innovations In science and technology                      | <input type="checkbox"/> |

- viii.practice good moral values and scientific attitudes in everyday life ☐
- ix. appreciate the contributions of science and technology for a comfortable life ☐

12. Based on the primary science objectives as in question 10, give your own views using the scale below on your understanding and the degree of implementing the objectives in your classroom and put the scale in the appropriate boxes

*(Please use the scale below to give your views and put the appropriate scale in the boxes provided)*

I understand and it is easy to implement = 1, I understand but it is difficult to implement = 2

I understand but I do not know how to implement = 3, I do not understand = 4

The objectives of primary science education are to give pupils the opportunity to:

- i. develop thinking skills to increase intellectual capability ☐
- ii. increase interest in the environment ☐
- iii. develop scientific skills, attitudes and an inquiring manner ☐
- iv appreciate the orderliness of the universe ☐
- v. gain knowledge and understanding of the scientific concepts and facts in order to understand themselves and their environment ☐
- vi. develop the ability to solve problems and make responsible decisions ☐
- vii. increase their ability to cope with the latest contributions and innovations in science and technology ☐
- viii.practice good moral values and scientific attitudes in everyday life ☐
- ix. appreciate the contributions of science and technology for the welfare of man ☐

### SECTION 3.

This part of the questionnaire is about your views on teaching strategies in science lessons.

13. The following is a list of statements about the teaching of science. Indicate how far you agree or disagree with each statement using the scale below.

Points to remember when rating the statements below:

To bear in mind **CHILDREN IN YOUR SCHOOL**, their background and ability and how they will affect your teaching strategies and to bear in mind **YOUR OWN VIEWS/OPINION**.

*(Please use the scale below in rating the statements and put them in the appropriate boxes)*

Strongly agree = 5, Agree = 4 , Not Sure = 3, Disagree = 2, Strongly disagree = 1

In Science lessons:

- i. I always use open ended questions to encourage my pupils to elaborate their responses ☐
- ii. It is difficult for me to encourage questions and ideas from my pupils to direct lessons and whole instructional units ☐
- iii. It is difficult for me to promote pupils' leadership qualities as a result of the learning process ☐
- iv. I encourage my pupils to use alternative sources of information both from written materials and experts ☐
- v. I encourage my pupils to test their own ideas, i.e. by answering their questions, their guesses as to causes, and their predictions of certain consequences ☐
- vi. I think it is not necessary to encourage my pupils to challenge each others' conceptualisation and ideas ☐
- vii. I always make sure that my pupils have adequate time for reflection and analysis after each science ☐



lesson

- viii. I find it difficult to use all the ideas my pupils generate during teaching session

☐
- ix. I respect all ideas my pupils generate

☐
- x. I find it difficult to encourage my pupils to collect real evidence to support their ideas

☐
- xi. I am not able to determine if my pupils are able to reformulate their previous ideas

☐
- xii. I often use co-operative learning strategies that emphasise collaboration, respect, tolerance, individuality, and the use of division of labour tactics.

☐

14. What role do you play in your science lessons?  
*(Please tick ✓ at the appropriate box under column (a), you may tick more than one. Then put an \* for the most frequent role you play in your science lesson under column (b) in one box only)*  
In my science lesson I act as:

	(a)	(b)
a facilitator	<input type="checkbox"/>	<input type="checkbox"/>
a giver of information	<input type="checkbox"/>	<input type="checkbox"/>
a motivator	<input type="checkbox"/>	<input type="checkbox"/>
a class controller	<input type="checkbox"/>	<input type="checkbox"/>
a researcher	<input type="checkbox"/>	<input type="checkbox"/>
a classroom manager	<input type="checkbox"/>	<input type="checkbox"/>

*(For question 15, please write in the space provided)*  
15. The idea ‘pupils as active learners’ means that pupils are able to generate ideas and opinions and able to test their ideas with their own initiative.

Is the idea ‘pupils as active learners’ applies to your science lesson. If it is/is not so, why?

.....

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.....

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.....

..

**SECTION 4.**  
**This part of questionnaire is about the science resources in your school.**

This part of questionnaire is to find out your views on the science resources in your school.

*(Please circle in the appropriate answer)*

16. Do you feel there are enough science books available for reference in your school?

YES / NO
17. Do you feel there is enough science equipment and materials in your school?

YES / NO
18. Do you use the science room for your lesson

*(Please tick ✓ in one box only)*

Never

☐

Sometimes

☐

Often

☐

19. If you use the science room, the feature in the science room that help you most in your lesson.

*(Please use the scale below in rating the feature of the science room and put them in the appropriate box)*  
Strongly agree=5, Agree=4, Not sure=3, Disagree=2 , Strongly disagree=1

- a. It is easy to access science equipment and science material

b. The arrangement of chairs and desks help for easy group-work activities

c. The availability of teaching aids such as charts, OHP, etc in science room

d. It is easy to control pupils during activities in science lesson
- ☐

☐

☐

☐

20. If you sometimes or do not use the science room, the reason for not using the science room

*(Please use the scale below in rating the reason for not using the science room and put them in the appropriate box)*  
Strongly agree=5, Agree=4, Not sure=3, Disagree=2 , Strongly disagree=1

- a. There is no science room in my school

b. The science room is use to store science equipment and materials, etc.

c. The science room is too small to accommodate my pupils

d. it is difficult to control pupils movement and behaviour in science room
- ☐

☐

☐

☐

**SECTION 5. This part of the questionnaire is to find out how you organise the pupils in your science lesson.**

21. What is the closest description to the way you organise your pupils for science lesson?  
*(Please tick ✓in one box only)*

- a. Always in small groups, no whole-class teaching.

b. Mostly in small groups, some whole-class teaching.

c. Mostly whole class, some small group work

d. Always as a whole class, no small group work
- ☐

☐

☐

☐

22. For science do you group children by ability?      YES / NO  
*(Please circle the appropriate answer)*

23. If you group children by ability, what are you guided by?  
*(Please tick ✓in one box only)*

- a. Overall level of ability ☐

b. Maths ability ☐

c. Science ability ☐

d. Language ability ☐



24. What sorts of task do you give pupils?  
 (Please tick  $\surd$  at the appropriate box under column (a), you may tick more than one. Then put an \* for the most frequent task you give your pupils for science lesson under column (b) in one box only)

	(a)	(b)
a. All pupils are given the same science activities	<input type="checkbox"/>	<input type="checkbox"/>
b. Pupils always generate their own activities	<input type="checkbox"/>	<input type="checkbox"/>
c. The starting points are the same, but pupils develop activities in an individual directions	<input type="checkbox"/>	<input type="checkbox"/>
d. Pupils are given modified tasks according to their ability	<input type="checkbox"/>	<input type="checkbox"/>
e. All pupils are given the same task and take them forward as far as possible	<input type="checkbox"/>	<input type="checkbox"/>

**SECTION 6.**

This part of the questionnaire is about your views on pupil characteristics in your science lesson.

25. Below is a list of skills in primary science that has been widely accepted as relevant. . Most teachers will ensure that a majority of these skills are achieved. In practice however, it seems likely that these skills will be in conflict with one another in such a way that the pursuit of any one renders the attainment of some of the others to be less likely. When such a conflict occurs, one of the skills must be given preference over the others; one skill becomes more important than the others.

Bearing in mind the possibility of conflict, and based on your experience teaching KBSR science, please assess the importance of each of these skills using the scale below. It is IMPORTANT to bear in mind also when rating these statements **CHILDREN IN YOUR CLASS**, their background and abilities and how these effects the skills they should achievedd.

*(Please use the following scale)*

1 = the skill is very important, 2 = the skill is important, 3 = the skill is of relatively minor importance  
 4 = the skill is unimportant

The child should be able to:

i. develop critical and discriminating attitudes	<input type="checkbox"/>
ii understand all scientific concepts taught by the teacher	<input type="checkbox"/>
iii. handle scientific materials and specimens properly	<input type="checkbox"/>
iv. memorise concepts taught in preparation for their national examination.(UPSR)	<input type="checkbox"/>
v use scientific drawing with great accuracy	<input type="checkbox"/>
vi. talk about his own and other’s opinion/ideas in a reasonable way	<input type="checkbox"/>
vii.develop creativity and inventiveness in some fields	<input type="checkbox"/>
viii. convey his meaning clearly and accurately during discussion	<input type="checkbox"/>
ix. know some simple and basic science process skills such as; observation, prediction, making inference, classifying and communication	<input type="checkbox"/>
x. acquire knowledge and information from written materials, for example summarising, taking notes accurately, using the library and computer	<input type="checkbox"/>
xi. show a set of scientific values on which to base his/her behaviour, for example honesty, sincerity and personal responsibility, tolerance, respect, appreciating others, their feelings, views and capabilities	<input type="checkbox"/>
xii. plan independent work where s/he is capable of using the integrated science process skills such as	<input type="checkbox"/>

making hypotheses, manipulating variables, analysing information, self-experimenting and organising his/her own time

26. Now select those skills in question 25 which seem to you the most important by placing the relevant numeral, i-xi, in each of the three boxes below which your pupils will be able to achieved.

Most important skill ☐ Second most important skill ☐ Third most important skill ☐

**SECTION 7.**

This part of questionnaire asks your opinion on how of the factors below influence your implementation of the primary science curriculum.

27. Study the following list of factors and rate the degree of influence each factor has on your implementation of the curriculum.

*(Please use the following scale)*

Very strong influence = 5, A strong influence=4, Some influence = 3 , Only little influence = 2 , No influence =1

- |  |                          |
|--|--------------------------|
| i. Head Teacher of your school   | <input type="checkbox"/> |
| ii. Head of the Science Department   | <input type="checkbox"/> |
| iii. District Education Officer  | <input type="checkbox"/> |
| iv. Level of professional training of teachers                             | <input type="checkbox"/> |
| v. Level of opportunity for in-service training                            | <input type="checkbox"/> |
| vi. Time off to attend courses   | <input type="checkbox"/> |
| vii. Level of provision of teaching material and equipment                 | <input type="checkbox"/> |
| viii. Co-operation among science teachers in the school                    | <input type="checkbox"/> |
| ix. Your own level of competence in science                                | <input type="checkbox"/> |
| x. What should be taught, e.g. through syllabus, schemes of work, or PUKAL | <input type="checkbox"/> |
| xi. Teacher Activity Centres   | <input type="checkbox"/> |
| xii. Pupils in your classroom  | <input type="checkbox"/> |
| xiii. Number of children in your class                                     | <input type="checkbox"/> |
| xiv. Abilities of children   | <input type="checkbox"/> |
| xv. Attitudes of children  | <input type="checkbox"/> |

**SECTION 8.**

This part of the questionnaire will ask your views about the primary science curriculum

28. Study the list of statements below. Please assess each statements according to your own views about the primary science curriculum using the scale below.

*(Please indicate your opinion by using the scale below)*

Strongly agree=5, Agree=4, Not sure=3, Disagree=2 , Strongly disagree=1

- |                                       |                          |
|---------------------------------------|--------------------------|
| i. I don't like teaching KBSR science | <input type="checkbox"/> |
|---------------------------------------|--------------------------|



- ii. Since KBSR, I have had to learn a lot of science ☐
- iii. I feel stress when trying to complete the science syllabus ☐
- iv. I don't feel confident to teach science ☐
- v. Assessment needs make it difficult to satisfy the requirements of the curriculum ☐
- vi. My children need to learn through practical activities ☐
- vii. KBSR science is not appropriate for my pupils ☐
- viii. I was asked to teach science against my wishes ☐
- ix. KBSR science is too abstract for the children I teach ☐
- x. The KBSR has made me get to grips with teaching science ☐
- xi. I think that promoting science as a separate subject in KBSR is appropriate for children in this decade ☐
- xii. KBSR science does not help me to meet my pupil's individual needs. ☐

## APPENDIX 2 Summary of teachers' responses on the objectives that are easily implemented

Respondent	Objectives	Reasons
AA	(ii)	Easy to tell pupils about the animal kingdom and indirectly pupils are interested.
BA	(ii),(iv), (viii),(ix)	All four can be done indirectly in the lesson.
JZ	(ii),(viii), (ix)	Obj. ii- easy to gain pupils interest. Obj.viii- instilled indirectly during lesson development. Obj ix- only for specific field.
MA	(ii),(viii), (ix)	Obj.ii- interconnected with other subject. Obj viii- indirectly and it is across curriculum. Obj ix- indirectly and only specific in the technology field.
MY	(ii),(v)	Obj ii- when they have knowledge so interest increases Obj v- easy to gain knowledge in various ways
NH	(ii),(iv), (vi),(vii), (viii)	Obj ii-pupils have prior knowledge. Obj iv- easy in a specific topic i.e. earth and the universe. Obj v-usually pupils able to solve problems with my guidance. Obj vii- already instilled in other subjects. Obj viii- I just have to give them the information and it's only in a specific subject.
NB	(iv)	By giving knowledge through explanation of the concept. Do not need a lot of equipment/apparatus just by giving reference books and charts and I explain directly to pupils. They do not have to search or look for information.
NU	(viii)	The easiest is to instil good values and scientific attitudes for example instilling the co-operative attitude and not to be selfish in a group ....that is the easiest.
RU	(ii),(viii), (ix)	Obj ii- all activity increases pupils' interest. Obj viii- is instilled also in other subjects. Obj ix- indirectly by looking at development in technology in the technology field.
SH	(ii),(iv), (viii),(ix)	Obj ii- increase pupils interest in experiment is easy. Obj iv- appreciating is easy...just depend on their attitude and it is implemented. indirectly in the earth and universe topic. Obj viii- instilled indirectly during lesson development. Obj ix- indirectly-show them science contribution so that pupils will understand it.
SS	(ii),(ix)	Obj ii- pupils experience it in the lesson and connect it to real life. Obj ix- instil indirectly during lesson development.
ZA	(iv),(viii),(ix)	All three do not need skills and it is not included in the exam and we can just instil it indirectly in the lesson.
DZ	(ii),(v), (ix)	Obj ii- easy to increase pupils interest with school's environment. Obj v- at least 75% of pupils have prior knowledge on the topics. Obj ix-indirectly by using electronic media in classroom teaching.

Table 5.2 Teachers' responses on the objectives that are easily implemented  
(Obj. – Objective)



### APPENDIX 3 Summary of teachers' responses on the objectives that are difficult to implement

Informant	Objectives (obj)	Reasons
AA	(iii),(v)	Obj (iii)and(v)-difficult to develop their scientific skills in the classroom during Teaching and Learning process. If the class A and B it is okay but C class is really difficult to use the inquiry approach. In the end we will be giving all the answers. The A andB class is okay but with my guidance.
BA	(i),(iii), (v)	Obj (i)and(iii)- it is my own weakness in trying to develop pupils' thinking skill and science process skill. I do not have enough knowledge to teach these skills to pupils Obj (v)- this is also my own weakness to make pupils understand. It's quite easy for the good pupils to understand the science facts but it's difficult for me to make the weak pupils to understand the science concepts.
JZ	(iii),(vi)	Obj (iii)- this objective emphasises pupils searching (investigating) therefore thinking but pupils are already trained to be recipient of knowledge so when they enter year 4, they become shy and difficult to communicate. So the problem is they cannot think to the expected level. This might be caused by their environment, knowledge, cannot understand teacher explanation and the new terminology in science. Obj (vi)- This objective is related to (iii) and pupils has self esteem problem. They are not brave enough to make decision so there is a relationship between obj (iii) and (vi).
MA	(i),(iii), (v),(vi)	Obj (i)and(iii)- I need to do references if I want pupils to carry out experiment and it is difficult to find references. Obj (v)- It is difficult for the weak class to look for information on their own. I have to tell them everything to the extend of how to look for information in the library. Obj (vi)- It is difficult for pupils to solve problems on their own, they are slow in doing it if I do not guide them. I have to guide them how to carry out the work, what to do first, second and the rest.
MY	(i),(iii)	Obj (i)and(iii)- It is difficult because pupils do not want to think. Pupils have been trained with spoon feeding method so when they enter year 4, they still wait for instructions. So to bring them to think I have to use a lot of approaches to stimulate their minds. I have to use things that are unique or creative then pupils will feel it as a challenge.
NH	(i),(iii), (v)	Obj (i)- Pupils are too lazy to think. They wait for teacher's instructions or wait for teachers to give them. I have to train them frequently by using questions. Sometimes they do the questions but answers are still wrong, they just don't think. Obj (iii)-It is most difficult for the weak class. These pupils even if you do it 10 times they still do not understand. Obj (v)- I feel pupils cannot fool science facts and the concepts too. If they cannot memorise facts and understand concepts, even the questions come out 10 times but put differently pupils will not be able to answer. Even for the good class only half of the class will understand.
NB	(i),(vi)	Obj (i)- The most difficult. The thinking skills follow the level of questions. If it is at low level pupils are able to answer but if we ask them to analyse, comment and critique, it is difficult for them to do so. Pupils in this school they read less so they cannot give opinion and their knowledge is limited. They cannot give ideas. There are a lot of reading materials but pupils prefer light reading like fiction, the materials on knowledge do not get their attentions. Obj (vi)- It is also difficult and it is the same reason as obj (i). They lack knowledge so when I give them problem they have no self confident to solve it, they are too dependent on teachers.
NU	(i),(iii), (vi)	Obj (i)- It is difficult. Obj (iii)- Pupils need to think too to do the scientific skills, so to do it in inquiry manner I have to tell them what to do. I have to explain first. So for the good class I explain briefly but for the weak class I have to tell them step by step. Obj (vi)- This is difficult for teachers to let pupils solve problems. I need to

		guide them especially for weak class but not so for good class.
RU	(i),(iii), (v),(vi)	<p>Obj (i)and(vi)- Pupils just cannot think, even though I say I encourage them but they cannot think scientifically. I have to guide them a lot. If I give them a problem they cannot develop it. This means they lack reading and cannot think a lot. So their knowledge is limited and not wide.</p> <p>Obj (iii)- It is difficult to do inquiry because pupils do not know how to think so it is difficult for them to do so. I have to give, I have to guide them then they will be able to do it. Pupils need to be guided to do the inquiry and it takes time.</p> <p>Obj (v)- about this objective gaining knowledge even if I give them reading materials to read at home they do not do so. I have to give them a lot of exercise questions. It's like drilling and it takes time. Understanding concepts and facts are difficult among pupils. Even if I have explain once or twice they don't really understand. For the good class I still have to explain 2/3 times if not they still cannot understand so that is difficult. For those who read a lot, it's easier but not for those lazy pupils.</p>
SO	(i),(iii), (v)	<p>Obj (i)- to prepare pupils for the thinking skills is difficult. I act as a facilitator and pupils are the one carry out learning. Meaning that we give a problem and pupils solve problems and I as teacher only give guidance but it is difficult to instil thinking skill. To ask pupils to make conclusion is also difficult for pupils. They do not see what they should do, thus they cannot give the conclusion....It is difficult.</p>
SH	(i),(iii), (vi)	<p>Obj (i)and(iii)- to develop pupils' scientific skill is easy for good pupils and the same with thinking skills. Even for the good class not all will be able to get the thinking skills.</p>
SS	(iii),(v)	<p>Obj (iii)-they cannot master the science process skills and they need teachers' guidance</p> <p>Obj (v)-base on my experience when pupils enter year 4 they have little science knowledge and little understanding of science facts and concepts, for example, they do not know the science terminology.</p>
ZA	(iii),(v)	<p>Obj (iii)and(v) most difficult because of pupils' background, my pupils are from the rural areas so their reading is limited. Based on my experience teaching them, they have very little prior knowledge and lack of reading. If I ask them to read in the library, they will be reading storybooks. This is the problem in teaching science and I tried but it is difficult to implement</p>
DZ	(iii),(vi)	<p>Obj (iii)- It is difficult for pupils to achieve because pupils do not see science concepts in everyday life. So there was no inquiry at all. When there is science and the science learning emphasises the skills, pupils have difficulty to achieved it, and not many pupils will be able to achieve it.</p> <p>Obj (vi)- For this objective, I think we do a lot of practical work which in the end we want a result and sometimes not all the practical work gives result that we hoped for. So usually in practical we only want to emphasise that pupils will be able to do the processes that I identified.....that I determined but to make a responsible decision they might not be able to achieve all....maybe a difficult practical work they won't be able to get results.</p>

Table 5.3 Teachers' responses on the objectives that are difficult to implement



# APPENDIX 4 Summary of teachers' perceptions of the objectives that are difficult to understand

Informant	Objective	Reasons
AA	(vii)	It is difficult to understand. Does it have any relation with obj. (ix) or does it mean we apply the advancement of science and technology in our life I just don't know.
BA	(vii)	I said it is difficult earlier but maybe I don't understand fully. What contribution and innovation.
JZ	(iv)/(vii)	What is it actually I don't know.
MA	None	None
MY	(vii)	To cope with the latest contribution of science and technology does it mean pupils using the technology product for example telephones, the person who invent it is creative, but person who copy it make it better. So does it mean pupils cope with the level of better innovation or is it the contribution existed to be renewed or what?
NH	(vii)	I seldom use this for my pupil.
NB	(iv)	Arrangement, I don't know what this means and orderliness in nature. From what aspect. That is why I put it least important.
NU	(vii)	How to cope, what form of contribution and innovation, I don't understand it so I do not implement it. My understanding is that it is maybe suitable with secondary school. I don't understand so I cannot explain it.
RU	(vii)	For me I don't know this one, for pupils able to cope with the contribution until what level and is it possible for pupils to do so. How...
SO	None	
SH	(vii)	I don't understand this objective, is it for primary school maybe it is applicable for the secondary school
SS	None	
ZA	(vii)	I don't understand, I just don't understand
DZ	(ii)	What is it that to do with inquiry.

Table 5.4 Teachers' perceptions of the objectives that are difficult to understand

## APPENDIX 5 Summary of teachers' attitudes towards the primary science curriculum

Informant	Attitude On Primary Science	Attitude On Teaching Primary Science	Attitude On Teaching Primary Science In Relation To Other Subject
NU	<u>Good for the pupils</u> It's good for pupils because its important for their future so that their brain will develop and our nation will be a developed nation <u>Benefit the weak</u>	<u>Combination</u> Difficult initially and burdensome but now enjoyable. <u>Exam oriented culture</u>	Positive attitude towards science
NH	<u>As a preparation for the secondary school</u> It's an early exposure for them. <u>Content overload</u>	<u>Positive</u> I have great interest in science so I enjoy teaching science <u>Teacher concern on pupils science concept</u>	Positive attitude towards science
NB	<u>Good for the pupils</u> It's emphasis skills, increase interest and develop talent <u>Teacher argument on implementing science in year 4</u>	<u>Combination</u> Science quite difficult compared to other subjects but its enjoyable to teach. <u>Teacher reflect on pedagogy</u>	Positive attitude towards science
MY	<u>Implement earlier</u> It should have done earlier, last time there was science, it should have continued not stop and then mix it with other subjects. <u>Science process skills (-)</u> <u>Teacher argument on implementing science in year 4</u>	<u>Positive</u> I feel very happy because it is my field	Positive attitude towards science
BA	<u>As a preparation for the secondary school</u> Preparation for secondary school, I can see that there is a bridge of knowledge from y6 to form 1 <u>Teacher argument on implementing science in year 4</u>	<u>Positive</u> If you asked about feelings then it is enjoyable	Positive attitude towards science
AA	<u>Good for the pupils</u> It increases pupils interest in the subject	<u>Positive</u> Something new for me so I enjoy it	Positive attitude towards science
JZ	<u>Primary science is difficult</u> The standard is too high, I remembered last time I learn science it was simple. This one is more detail and the form 1 of the sec. School is also learning up to that level. I feel it should be introduced but the scope must be reduced. <u>Pupils b/ground</u> <u>Teacher inadequacy of pedagogy</u>	<u>Combination</u> Difficult initially But enjoyable and challenging too	Negative attitude towards science



	<u>content knowledge</u>		
RU	<u>As a preparation for the secondary school.</u> It will be easier for the pupils when they go to sec. School since they have basic science so it will be easier for the secondary school teacher <u>Thinking skills (+)</u>	<u>Combination</u> Interested in science, when asked to teach I was happy but afraid to teach it initially but it's okay.	Positive attitude towards science
SO	<u>Good for the pupils</u> Pupils able to explore their environment and enjoy learning new things	<u>Combination</u> It's an enjoyable subject but need revision to prepare before teaching.	Negative attitude towards science
SH	<u>As a preparation for the secondary school</u> Good, science is expose earlier to pupils and it will be easier for them when they go to secondary school. Science process skills and thinking skills (-)	<u>Positive</u> I am interested in science, yes I like science <u>Exam oriented culture</u>	Positive attitude towards science
SS	<u>Good for the pupils</u> I hope to develop pupils with ability in making decision, make conclusion and able to generate ideas <u>Independent pupils</u>	<u>Combination</u> Interested in science but initially face many problems in teaching strategy	Positive attitude towards science
ZA	<u>Good for the pupils</u> I feel it is good because last time they are exposed only in the sec school but now they have basic so it will be easier for them.	<u>Positive</u> Interested since I was from science stream	Positive attitude towards science
MA	<u>Good for the pupils</u> It is good for the pupils but ministry's planning was bad. <u>Teacher unsatisfied with ministry's method of implementing the program</u>	<u>Positive</u> It is an interesting subject	Positive attitude towards science
DZ	<u>Earlier implementation</u> It should be done earlier, last time when I was schooling there was science and then it is only an element in a subject but now it is a single subject, it is good <u>Teacher argument on implementing science in year 4</u>	<u>Combination</u> It is challenging to make pupils understand concepts but I am interested in teaching science <u>Teacher concern on pupils science concept</u>	Positive attitude towards science

Table 5.5 Teachers' attitudes towards the primary science curriculum

## APPENDIX 6 Summary of values teachers hold in implementing the primary science curriculum

Informants	Good Science Lesson	Most Important Pupils Outcome In Science	Ways To Educate Pupils In Science
NU	<u>Approaches</u> Group activity-search for information, discuss in group and present in-front of class <u>Classroom organisation</u> Mixed ability <u>Feedback</u> Question-answer session at the end of lesson	Content Change of attitude	Instil interest through classroom activity-we must instil interest first by doing experiment, outdoor activity, it's like games and pupils love games so they will enjoy it.
NH	<u>Approaches</u> Experiment-at least there must be an experiment because in science usually have experiment <u>Classroom organisation</u> Mixed ability <u>Feedback</u> Written exercise	Content. Science process skills. Between content and science process skills pupils should have the science process skills as the most important outcome.	Through extra co- curricular activity- science clubs handle science garden, science quizzes
NB	<u>Approaches</u> Inquiry teaching approach-pupils raise problems, carry out the activity and get the concept by themselves. <u>Classroom organisation</u> Mixed ability <u>Feedback</u> During the activity- while doing experiment, their result and their presentation	Content Change of attitude among pupils	Through extra co-curricular activity- Science club-science week-competition-creating models, drawing models of vehicles for year 2020
MY	<u>Approaches</u> Experiment-when pupils have the science process skills, they will gain the thinking skill so when I asked them to analyse, classify then they will be able to do it <u>Classroom organisation</u> Mixed ability <u>Feedback</u> A question-answer session at the end of the lesson for a fast feedback.	Thinking skills	Teacher as role model
BA	<u>Approaches</u> Group activity- usually group activity is the best so far I give them and activity then discuss in group appoint a presenter and the present in-front of class <u>Classroom organisation</u> Mixed ability <u>Feedback</u> Monthly test and written exercise	Content Good science exam result	Other sources-science magazines- Parents guidance on science program on television
AA	<u>Approaches</u> Guided inquiry approach-from pupils experience and inquiry strategy but I have to guide them with enough material and explanation, pupils will remember easier through experience and they understand easily <u>Classroom organisation</u> Pupils mixed freely	Content	Library/books/ References



	<u>Feedback</u> Test and written exercise		
JZ	<u>Approaches</u> Experiment- there will be a lot of answers in the experiment as group or individuals, some are wrong, some are correct, I feel enjoyable like that. <u>Classroom organisation</u> Mixed ability <u>Feedback</u> Exercises	Content Thinking skills	Extra co-curricular activity-competition of science posters, scrapbooks and vivarium
RU	<u>Approaches</u> Experiment-when you give experiment, a teacher will give a problem to discuss what to do it's like an inquiry approach that the best. <u>Classroom organisation</u> Mixed ability <u>Feedback</u> During the activity- if I make a group discussion, then from the presentation of their result we will know if the group is able or not	Thinking skills	Science across curriculum  Extra co-curricular activity-exhibit model create by pupils in science club, science quiz and science trail
SO	<u>Approaches</u> Inquiry approach-we start with a set induction to probe pupils knowledge about the topic like we want to do inquiry strategy, we stimulate pupils until they are able to see what we really want to teach them. <u>Classroom organisation</u> Mixed ability <u>Feedback</u> Question-answer session at the end of lesson	Content Pupils attitude towards science	Library/books/ References  Environment
SH	<u>Approaches</u> Group activity-the best is it must have activity, a good planning there must be activity and conclusion, pupils must give conclusion to us, that is more effective. It must have group activity then individual activity, it must have worksheet, equipment and than it is complete. <u>Classroom organisation</u> Mixed ability <u>Feedback</u> Question-answer session at the end of lesson and exercises	Good science exam result	Through extra co-curricular activity-science club -science garden, scrap books competition.
SS	<u>Approaches</u> Experiment- based on my experience, the best is when pupils carry out experiment <u>Classroom organisation</u> Mixed ability <u>Feedback</u> Question-answer session at the end of lesson	Content Thinking skills	Science across curriculum
ZA	<u>Approaches</u> A lot of strategies but mostly experiment activity <u>Classroom organisation</u> Mixed ability	Good science exam result	Environment Library/references/books

	<u>Feedback</u> Question-answer at the end of lesson		
MA	<u>Approaches</u> Experiment- I always saw that the strategy that give the most interest to pupils is doing experiment, they are really showed enthusiasm when asked to collect the apparatus and cant wait to start the experiment. <u>Classroom organisation</u> Freely mix gender <u>Feedback</u> Test	Pupils self satisfaction	Extra co-curricular activity- scrapbooks
DZ	<u>Approaches</u> Experiment- science teaching is more towards practical. Practical is the best because things we want to show pupils sometimes can't be shown in a short time, sometimes it take a day or two maybe a week so practical is the best way. <u>Classroom organisation</u> Mixed ability <u>Feedback</u> During the activity-I look at the result of the practical, so I look at the process from the starting they carry out the experiment until the end. So I look at the result, the way they do it and the process of clearing up from there we can anticipate their understanding.	Good science exam result  Thinking skills	Extra co-curricular activity- through clubs and other uniform unit.  Environment

Table 5.6 Values teachers hold in implementing the primary science curriculum



## APPENDIX 7 Summary of teachers' beliefs in primary science education

Informant	Philosophy On Science	Belief On Science	Philosophy And Belief Effect Implementation	Opinion On Science As A Process Of Inquiry	Science B/Ground Equip Teachers To Teach Science
NU	Future awareness	Science is important for our pupils	Implementation with future awareness agenda	Agree, experiment	Yes, but problems with the science process skills
NH	Classroom based need	Science is our life	Implementation with curriculum agenda	Agree, Experiment	Yes, science knowledge from the distant learning for a degree
NB	Classroom based needs	Science is our life	Implementation with curriculum agenda	Agree, Not applicable to all pupils	Yes, but not 100%,it prepares for the basic knowledge
MY	Science as god's supremacy	Science related to religion	Implementation with religion values	Searching	Yes, I was from science stream and my option in teacher trainee was science and I have taught science in secondary schools before
BA	No response	No response	No response	Agree, Not applicable to all pupils	No, 30% because secondary school is different from primary so I don't see it helps so much
AA	No response	No response	No response	Agree, Experiment	Yes, I took science in Form 4 and form 5. I feel I am more prepared and confident to teach science compared to teachers from art stream
JZ	Science as god's supremacy	Science is important to our pupils	Implementation with religion values	Agree, Thinking skills	No, sometimes I have to find more. There are topics that I can teach and there are topics I need to find out more. Sometimes the pupils have good b/ground with mothers having degree in science and their questions are of high standard
RU	Classroom based needs	Science is related to religion	Implementation with curriculum agenda	Agree, Thinking skills	Yes, because I have learnt science in form 1, the integrated science then the form 4and5 science with bio, physis, chemistry when I taught I remembered what I've learnt before so no problem from the content perspective and when I make reference there is no problem
SO	Classroom based needs	Science is important for our pupils	Implementation with curriculum agenda	Agree, Experiential learning	Yes, I was from a science stream class, it helps a lot. I feel if a teacher without science b/ground she cannot teach well.
SH	Future awareness	Science is related to religion	Implementation with future awareness agenda	Agree, experiment	Yes, but there is little experience, only the knowledge but it does not prepare us to teach primary science because it's different
SS	Classroom based needs	Science is our life	Implementation with curriculum agenda	Agree, Experiment	No, all this while I was only exposed to the Man and Environment and it doesn't have thinking skills. I only attended the orientation course so from that perspective I feel it's not adequate for me to

					teach science, Yes I feel inadequate because it is a new thing
ZA	Classroom based needs	Science is important for our pupils	Implementation with curriculum agenda	Agree, not applicable to all pupils	No, not enough, I have to add more, sometimes I don't know how much to teach for the primary science curriculum, how much and how deep. Another thing is the process skills, it's difficult to instil these skills. We have to instil but the year 4 we cannot instil the difficult ones, they are able to do as far as observation and classification. Last time we don't have the science process skills and thinking skills in science. They can learn as far as the basic knowledge.
MA	Future awareness	Science is related to religion	Implementation with future awareness agenda	Agree, not applicable to all topics	Yes, I have the science experience from primary, secondary school then I make a lot of references from the form 3, and form 5 science books. For example the biology is related to the plants and animals so the previous experience helps. But for me some of the topics in year 6, I can't master for example the topics on earth and universe.
DZ	Science as god's supremacy	Science is our life	Implementation with religion values	Agree, Questioning minds	No, to me it's not enough. For me what I get from the general science in the secondary school is not enough to teach year 4,5,6 science that's why I went for the 14 weeks course as a distant learning. From there I saw that the module is quite a high standard. Compared to what was in the module with the general science in the 80's it is definitely not enough to prepare me teach primary science.

Table 5.7 Teachers' beliefs in primary science education



## APPENDIX 8 Summary of the factors influencing the way teachers teach science (teachers' beliefs)

Informants	Pupils	In-Service Course	Colleagues	Others
NU	No influence	Yes, it helps in the teaching strategies	Influenced, discussion on teaching strategies	Headteachers. Time allocated too short
NH	Pupils' ability	Yes, it helps in the science process skills(SPS) but not on teaching strategies	Influenced, Discussion on teaching strategies.	Depends on topics of the lesson
NB	No influence	Yes, it helps on teaching strategies	No influenced, they only commented on my strategies.	The text book and teacher guide book Time allocated is too short
MY	No influence	No influence because I am giving the course, I am influencing the teachers	No influenced	Influence by Islam religion
BA	Pupils' ability	Yes, it helps on the strategy but it is not applicable mostly in the weak class	Influenced co-operation she gave in teaching aids and discussion on strategies.	Science Equipment -the order always came late Self attitude Time allocated is too short
AA	No influence	Yes, initially but later I modify according to class ability, activity and environment.	Influenced, sharing of ideas and discussion on teaching strategies	Using other reference books but not the text book Curriculum guide
JZ	Pupils' ability	No, I only attended one course and they only discuss on format question on SPS	Influenced, discussion on teaching strategies	Science equipment and materials-inadequate
RU	Pupils' prior knowledge	No, it does not influence much, a lot is from my own reading	Influenced, discussion on teaching strategies	Self preparation
SO	Pupils' attitude Pupils' prior knowledge	Yes, it helps on the SPS	Influenced, discussion and sharing of ideas on topics that are not sure/confident to teach.	
SH	Pupils' ability	No, not much help about 30-40% in the first year mostly I learn own my own.	Influenced, sharing of experiment materials and equipment for the pupils.	Note giving
SS	Pupils' ability	Yes, it discusses on SPS and teaching strategy but it is not applicable in classroom I have to modified	Influenced, discussion on teaching strategies	-
ZA	Pupils' ability	Yes, it helps on the SPS and teaching strategy and it's effective for the children	I influenced them since I am head science teachers so I discuss the teaching strategies with them	-
MA	Pupils' ability	Yes, it helps in teaching strategies	Influenced, discussion of teaching strategies	Depends on topics of the lessons
DZ	Pupils' ability Pupils' prior knowledge	Yes, it helps in the SPS	Influenced, discussion on teaching strategies	

Table 5.8 The factors influencing the way teachers teach science

## APPENDIX 9 Summary notes of classroom observations — A focus on teachers content knowledge

1. AA was observed twice and her content knowledge in these science topics was giving pupils the concepts on animals' eating habits and the characteristic of lights. In the first observation, her content knowledge was observed when she defines the terms of herbivore, carnivore and omnivore and when she tried to link the conceptual content to children's informal experiences of the mouth-parts of animals with their eating habits. In the second observation, teacher's content knowledge was only seen when teacher explained the use of the concept on reflections of light in everyday life. Her examples of rear mirror in cars and periscope showed that it was conceptually correct.

2. BA was also observed twice and her content knowledge was on explaining to pupils the effect of heat energy. Here her content knowledge was observed when she defined the term heat and she monitors the use in pupils' answer and another of her content knowledge was observed when she gave examples of the heat energy (by using the transparencies). Both of her content knowledge was correct

3. JZ was also observed twice. The lesson on animals movement, teacher's content knowledge was observed when she concluded the lesson for her pupils by explaining the movements of animals and also explaining the physical characteristics of animals with certain movement. In her second lesson, it was observed that her content knowledge showed when she discussed the result of their activity through worksheet (most of the answers were given by teacher). However, both of her content knowledge was correct.

4. MA was observed once. His content knowledge was observed when he discussed the results of the activity and during conclusion of the lesson. He mostly defined the term of conductor and insulator and monitors it uses in the activity.

5. MY was also observed once. His content knowledge was observed when he concluded the lesson for his pupils. From pupils activity he explained the basic need of animals discussed in the lesson.

6. NB was observed twice. Her content knowledge in her lesson of animal reproduce was observed when she explained on ways animals' breed by giving examples. During this phase it could be seen teacher tried to links conceptual content to children's informal experiences. Her second lesson on magnetic material, teacher's content knowledge was observed when she explained the magnetic materials are made of iron.

7. NH was observed twice. In her first lesson, teacher's content knowledge was observed twice. Firstly, when she explained briefly the ways of preservation of food. Here she tried to link conceptual content to children's informal experience of food becoming bad. Secondly, when she gave the definition of the term of pickling. In the second lesson of acceleration, teacher's content knowledge was not observed since this lesson was only carrying out the activity of the lesson. The theory part has been explained on previous lesson (told by teacher during the lesson to researcher)

8. NU was also observed twice. In her first lesson on food web, a number of her content knowledge was observed. Firstly, she gave a definition of food chain. Then she asked for conceptual understanding when she asked them what would happen if there were no grasses. Another evidence of her content knowledge was when she showed them a transparency on habitat in a pool and asked pupils to develop food chain and food web from the picture. This showed her content presentation was correct. In her second lesson, teacher focused on science process skills, thus much of her science pedagogical skills emerged but not much of content knowledge. However, the content knowledge was only observed when she discussed the result of pupils' activity of the insulator and conductor.

9. SO was observed once. A number of her content knowledge was observed during the lesson. Firstly, in introduction teacher links present lesson conceptually to previous lesson when she mentioned that food is the basic need of living things and that animals have different eating habits. Another of her content knowledge was when she defined the term of herbivore, carnivore and omnivore. Then she links conceptual content to children's informal experience of human eating habit. Lastly when she gave a problem on the animal eating habit, here she asked for conceptual understanding rather than just for factual or procedural knowledge.

10. SS was observed twice. In his first lesson, his content knowledge was observed when he linked present lesson conceptually to previous lesson of the plants basic need of water. In this lesson one wrong content knowledge that teacher made was when he mentioned that boiled water do not permit oxygen to get into it not that oxygen has been removed by boiling. In his second lesson quite a number of his content knowledge was observed. Firstly when he links conceptual content to children informal experience. This was done in the introduction phase by asking pupils why do they need to eat and drink and link this with plants basic needs. Another content knowledge was when teacher give examples of rat eating bread showed that the example is conceptually correct. However, when teacher starts explaining the photosynthesis of plants, this showed that teacher content presentation is not developmentally appropriate yet to children's level in this lesson.

11. SH was also observed twice. In her first lesson, her content knowledge was observed when she tried to link conceptual content to children's informal experiences. This was done when she asked pupils to role-play as doctor and patient getting a treatment and doctor was using a clinical thermometer. Another evidence of her content knowledge, was when she explained on the thermometer and the method of reading a thermometer. This was done, by using a prepared transparency of a picture and information on thermometer. This showed that her content presentation is accurate. In her second lesson, the content knowledge was not observed because she spent much time on correcting pupils' activity and dictating correct answers on the task sheet.



12. ZA was also observed twice. In her first lesson the only content knowledge observed was when she links present lesson conceptually to previous lesson. The previous lesson was on food chain and the present lesson was on food web. The reason for no content knowledge could be observed was the whole lesson was pupils drawing the plants/animals of the food web. (not emphasised by teacher to write names of plants/animals only) In her second lesson, she also link present lesson conceptually to previous lesson when she asked on apparatus using heating elements and the lesson on effect of heat. Another of her content knowledge was observed when teacher made conclusion, here teacher links conceptual content to children informal experiences. This was done by explaining that effect of heat in the electric appliances important in life and gave example of rice cooker.

13. DZ was also observed twice, In his first lesson, his content knowledge was seen when he linked present lesson conceptually to the previous lesson. Here, it was done, by asking pupils questions on sources of electric current. He then linked conceptual content to children informal experience when he asked pupils the example uses of batteries. He then asked what energy changes happened when a 'torchlight' is used. Another evidence of his content knowledge is when he linked conceptual content to children's informal experiences of electrical appliances at home with the changes of energy happened in the electrical appliances. In his second lesson, his content knowledge was observed when teacher linked present lesson conceptually to previous lesson. Here teacher tried to link pupils' knowledge on electric circuit so that they will be able to test the conductor and insulator materials through the electric circuit. Another evidence showing teacher's content knowledge is when teacher asked for conceptual understanding rather than just for factual or procedural knowledge. This is when teacher asked why were wires wrap by rubber made materials. Another evidence is when teacher defines term of insulator and conductor and monitors the use of the terms.

## APPENDIX 10 An overview of lessons / Lesson observation notes

In this part, description of each of the lessons observed was given by way of an overview.

### Observation description

Teacher's name: SO

Date: 12/2/99

Time: 11.05-12.05

No of Pupils: 42

Topic of lesson: Animals' eating habits

SO starts the lesson by asking pupils questions 'What food have you taken during recess time?' Teacher points to several pupils and asked what did they eat during recess time. Pupils responded by giving all type of foods they have eaten. Then she said that from this they could see that most of them eat different food. Then teacher asks another question, 'Why do you need to eat?' One pupil responded by saying to live. But teacher did not respond to his answer but she lead the question by saying 'so that we cannot'....but pupils still say 'to live'....then teacher continued to say... 'to live and so that we wont get hungry'. Then she asked for any other reasons. Pupils' responses were 'to grow', 'to give energy', 'to become active and clever' and 'not to die of hunger'. Here teacher said that the reasons they give are related to the previous lesson — that food is the basic need for human. Here teacher is linking the previous lesson with today's lesson by saying that they will be discussing that other living things need of food. She said that is 'animals' and continued by asking a simple low (no) level question, 'Do animals need to eat?' Pupils answered as a whole class 'Yes', then teacher continue to say 'yes animals need to eat to live'. Then teacher asked pupils for example of animals and their food. Then a girl answered, 'a goat eats grass'. Another pupil said, 'fishes eat worms'. Then a boy said 'a rabbit eats plants'. Teacher then immediately continued to her plan by saying that they will be doing activity group. This event shows that teacher did not even use the pupils responses to continue for her next activity and did not even give any feedback to pupils answer. Here, what the teacher is trying to do is to link the concepts of food as the essential basic need for living things and the concept of animals eating habits. Here I feel teacher should have taken the opportunity from pupils' responses on some type of the animals mentioned and their food to continue the lesson. The answers pupils gave show that they already have some ideas of different animals eat different foods. But instead teacher immediately said they would do group activity. She said she will give picture card and they are to discuss in a group and state from the picture. Then teacher explain by showing example and said that she give 3 arrows and asked them to write down the food the animals eat at the arrows and if they found that if they have more than 3 food they can add more arrows. Here teacher is giving instruction on what they are supposed to do in their discussion. Then she called up the group leader to get the picture card from her.

The pupils at this point become noisy and again teacher instructed them to put the picture in the middle and pupils started asking questions. But teacher asked for attention again to listen to her instructions. Here, the teacher once again instructs pupils to discuss in their group to state the food the animal (in the picture) eats. She called the name of few pupils to put the picture in the middle so that everyone can see and give their opinions. Then tell the class to start discussing. At this point pupils are busy discussing and the class became a bearable noise.

The strategy used in the lesson was discussion. Teacher provide picture cards of an animal for each group with a prepared sheet of task with a simple concept map to discuss in the group the food the animal (picture card) eat. After all groups have received the material from the teacher, they are asked to discuss in a group using the prepared material. Teacher then moves around the room and asked pupils to predict their results. Once in a while, she intervened by saying and stressing to focus only on the food the animal discussed. During this period, SO noticed that a group was having some sort of difficulty and helped them through questioning them. This activity took about 10 minutes. Then teacher asked if they have finished, but she gave a minute or two for them to finish.

Then teacher instructed pupils to stop discussion and prepare to represent their discussion to the whole class. The teacher said that she wants every group to send their representative to read what they have written. Then she asked a group why are they so noisy and what was their problem. It seems that the representative do not want to volunteer since he has gone to take the picture. Here teacher asked them to change turn. Then teacher called up the first group. Teacher asked the boy to put up his picture and asked him to read what have been written. The boy said a lizard eat flies, termites, ants and mosquitoes. Teacher repeated the answer and then asked another group to come out. During the presentation, some pupils disagree with some of the group answers for example a group discussing the food rabbits eat saying that rabbits eat bread. And another group discussing the food that ducks eat, include worms. The teacher then said that they will be discussing this in a short while after all groups have presented. All six groups were given the chance to present their result. After the presentation teacher asked questions to pupils to provide explanation and to clarify of the eating habits of animals.

Then teacher go through again the answers the first group gave and asked the whole class if there are any more food the animal eat. She did this for all the animals discussed.

Then teacher asked pupils to observe from all of the six animals discussed the differences in their food. Then she said between the six animals, was there any animals that eat similar types of food (more or less the same). A boy answered 'lizard and frog', another boy said 'duck and fish'. Another boy said 'rabbits and goats'. Then teacher repeated the answers the pupils said and asked pupils to look again at the previous answers given in the first activity. Then teacher asked what did they see in the food the 'lizard and frog eat'. She asked pupils in which group do this belong to. Pupils said small animals and teacher asked again which group (here teacher is looking for the answer she wants pupil to say)

She tried to lead the pupils to say the type of animals, pupils said the 'animals that live on land'. She once again said that they have learnt in living things is group into certain group. At this time a pupil mentioned 'herbivore'. Then she asked the pupil, what is herbivore and the pupil said 'do not know'. Then other pupils said 'carnivore'. Here teacher seems drawn back by the pupils responses and she was not happy with the pupils that came out with this term and asked the pupil who mentioned it to explain what it means. Again here she asked pupils that they have learnt that living things are group into two and what are they. Here, teacher ignored other pupils saying 'carnivore'. What is happening here was teacher tried to let (direct) pupils to come to a



certain conclusion from the discussed presentation i.e. there are animals eating plants only, animals eating meat and animals that eat both plant and meat. Here pupils mentioned again the term but teacher asked pupils to listen to what she wants to explain first and not the term yet. Then she continued, what is the other group, pupils said duck and fishes that eat everything plants and animals. Then here pupils in the background start saying carnivore.

Then teacher said, 'now I want to introduce to you that the group of animals eating plants only are called herbivore, then she explain the carnivore and omnivore. She asked whether they have been taught this previously some answered yes and some answered no. Then teacher continue by saying that if they have known this why are some of their answers are still wrong. Then teacher writes this down on the board. Then teacher introduces the term herbivore, carnivore and omnivore. To SO this is new to the pupils but it seems there were two pupils already knew the term but when asked what is the meaning they did not know. It can be seen that she was not happy with this unexpected event. She then explain the meaning of the term and make a link with pupils own experience of eating habit and asked pupils in which category can human be group into. After this explanation, teacher asked pupils to group and classify the animals according to their eating habits using the pictures they brought from home. They do this activity as a group. Here teacher tries to restructure pupils' ideas of animal eating habit (as teacher's teaching plan). During the activity pupils seems to be using the term introduced and classify the animals. Pupils seemed very much interested in the activity and discussing the work. Teacher moves from group to group to monitor pupils work and understanding of the concepts of animal eating habits. At an instant teacher seemed to intervene in a group by asking again the meaning of the term. After this activity, teacher again distributes a prepared worksheet that contain a simple concept map for pupils to classify the animals that they have group in the previous activity and fill it in the worksheet provided. This activity, for the teacher understanding is where pupils are applying the ideas. Then teacher intervenes again by saying that if they cannot remember the terminology to write them down on the worksheet at the bottom. But there are pupils still asking her the meaning of the term even though she has written them on the board. It's ironic that she did not refer pupils to the terms written on the board. Then teacher asked them whether they have finish or not. After sometimes, teacher said if they cannot finish the task they can continue it at home and asked them to stop because they are going to do another discussion.

Teacher seemed to make a conclusion that from the activity they can see that animals eat different type of food. Again teacher mentioned the herbivore, carnivore and omnivore and then said that she has a problem and wanted them to solve the problem and discussed it together in a group. In the last activity, teacher gives a written problem for pupils to solve as a group. Teacher wrote the problem on a transparency and read it to pupils. The problem teacher gave was as follow;

' There is an increase in number of rats in a rice field. Suggest a natural procedure that can be apply to control the number of rats' Then teacher asked them to discuss but it seemed pupils are eager to answer the questions. Then a boy answered by 'using owls' then teacher asked 'why do you use owl'. The boy answered that 'rats will be looking for food at night and owls will also look for food at night and owls eat rats as their food'. Then teacher asked pupils is there any other way. Pupils answered 'eagles', but teachers do the explanation by saying 'eagles also eat rats'. Then a girl said by 'putting traps' then teacher reminded her that the question asked, 'to use a natural procedure'. Another boy answered 'cats'. Then another boy mentioned 'snakes'. At this instant teacher asked why did they say all these animals are able to help to reduce the number of rats and pupils answered because 'rats are their food'. Then teacher asked in which group do these animals belong to. Pupils answered carnivore.

This to teacher is the reflection phase of the constructivism approach.

Finally, teacher concluded the whole lesson. She said that today they have learnt animals eating habits and again gave a lot of explanation on the concepts of animal eating habits. Then teacher asked if they have any questions. There were no questions and pupils were asked to finish and complete their work. I feel that the conclusion should be made by pupils since from the observation the pupils managed and able to understand the concept of animals eating habit. Here I feel that even though teacher said that she was using the constructivist approach but at the back of her mind she is the information dispenser and it closely resembles the authoritarian approach.

Teacher name: AA

Date: 24/2/99

Time: 8.45-10.15

No of pupils: 46

Topic of lesson: animals eating habits

Strategy: discussion

Approach: guided inquiry-discovery

Setting: classroom

AA started the lesson by showing 3 drawn pictures put up on the blackboard. Teacher asked pupils to observe these pictures and asked them what was the first picture. Pupils answered 'butterfly' and the teacher asked 'what is the butterfly doing'. Pupils answered 'it is feeding on nectar of the flower'. Then asked the second picture, pupil answered 'an eagle is eating a rat'. Then the third picture, 'a snake is opening it's mouth to eat a rat'. After showing these pictures, teacher asked pupils 'from the pictures what is it trying to show'. Pupils responded by saying 'food and animals'. Then teacher asked, 'are the foods eaten by these animals the same'. Pupils answered 'No' then teacher said that 'today they are going to look at animals eating habits'. Then teacher explained that animals eat different things and there are animals eating plants, eating meat and there are animals eating plants and meat.

Then after the introduction, teacher asked pupils to go into a group of five except a group has six members. Then teacher asked pupils to shift their chairs so that they could discuss easily. Then teacher distributed pictures for the group. Then teacher instructed them to look at the picture one by one and discuss the food that each animal eats. At this instant teacher move around to monitor pupils work. Then she asked the group to put up their hands when they have finished. Teacher mentioned that three groups have finished. Then teacher asked each group to appoint one pupil from the group to write on the board what they have discussed. At this point pupils become noisy commenting on other groups' result and teacher has to discipline the pupils to wait for the discussion later.

Then teacher go through pupils answers one by one on the same animals given to each group. Then teacher concluded that each group has similar answers. Then teacher said that she left out one picture that is the chicken and asked pupils what do chicken eat. Pupils answered group by group. Each group of pupils mentioned worms, rice, maize. Then teacher continued to state that



there are animals eating plants, animals eating meat and animals eating plants and meat. Then teacher asked how many can they class the animal. Then pupils shouted into '3 groups'. Here teacher started to introduce the concepts of; herbivore, carnivore and omnivore and explain the meaning of each one. But when she asked the pupils, pupils said they have known the term already. So teacher continued with the other activity. Teacher asked pupils to class the animals into the three eating habits using the previous pictures given to them in the first activity. Then teacher said that she would distribute the paper to do a table of classification. Then each group presented their result by reading their results to the whole class by a representative. After pupils' presentation teacher immediately show picture of an animal's mouth-parts. Then teacher said that 'a pupil mentioned that the animals have fangs and asked them what is the use of the fangs'. Then teacher said 'it is for cutting meats so that is the jaws of a carnivore'. Then said that 'usually the parts of the feet has sharp nails' and asked pupils the function of the nail. A pupils said 'to kill the animals' and teacher explain so that the animals can grip the animals to eat them. Then teacher asked 'how do snake capture its prey'. Then pupils give answers 'by the poison in the mouth'. Then teacher said there are many ways. Then teacher asked them to look at the 'mouth parts' of the herbivore. Then asked them what do they have, pupils answered they have teeth and teacher directed them to look at the molar and tell them they used the molar to grind the food. Then teacher asked pupils to go back to their respective places and told them that she wants to give questions. She distributed the exercise sheet for them to answer and this exercise took about 20 minutes and this is the teacher final activity until the end of the lesson.

#### Observation description

Teacher's Name: BA

Date: 17/3/99

Time: 7.45-8.45

No. of pupils: 31

Topic of lesson: Effect of heat energy

Strategy: practical activity-station method

Approach: guided inquiry-discovery

Setting: science room

Teacher started the lesson by asking a pupil to feel water in two beakers. Teacher asked how do their fingers feel like. Pupils said 'one is cold and one is warm'. Then teacher asked, 'why is that?' A pupil answered 'because it has heat'. Then teacher immediately told pupils that the topic for the day is 'the effect of heat energy' and wrote it on the board. Then teacher said that they have mentioned 'heat' so she asked them 'what is heat?' Then teacher gave examples 'if they run, how do they feel?' Pupils answered 'they will be sweating' and teacher asked 'why do they sweat' then teacher give the answer, 'because they feel hot'. Then asked again 'what is heat?', then when there is no answer the teacher link back to the first activity of the warm water. Teacher asked again the 'meaning of heat'. Then a pupil answered 'heat is the effect of hotness'. Then teacher explained that 'heat is the effect of hotness or heat is feeling of hotness or hotness that we get from hot water'. Teacher said 'when there is hot water we can feel the hotness'. Then she asked pupils 'the hotness is the effect of what?', pupils said 'heat' and teacher try to link this to that 'water is change into heat energy'. Then she asked pupils 'why is the other beaker of water cold' and she gave the explanation by saying that 'there is no heat in that beaker thus it is cold'. Then teacher defined the term heat and write in on the whiteboard. Teacher defined that 'heat is the effect of hotness that is derived from a process'. Then teacher gave an example of running again.

Then teacher explained that today they will be doing a station method activity according to groups. But before explaining further on the activity she asked more questions. 'What are other activities that make us feel hot?' Then pupils answered; 'sports activity', 'housework', 'working', then another pupil answered 'gardening'. At this instant teacher directed pupils to different examples (It seems that these answers were not what she sought for). She asked a pupil to switch on the light then asked pupils to explain what happened. Pupils answered that 'the light will become warm when there is electric current'. Then teacher directed them to understand that this is the effect of heat energy. Then she asked for other similar examples. Pupils give the examples of an electric kettle and explain of the concept of heat.

After this teacher explained to pupils of the station method activities and instructed that group one will go to 'station one', and group two to 'station two' and the rest follow. Then she said that they have to answer the questions on the activity at the station then wait for her signal to tell them to change. Here, teacher emphasised on the safety measure if handling hot things. Then teacher distributed the task sheet for each group to record their observations. And asked pupils to elect a secretary to do the recording. Then asked pupils to give a name to their groups and asked pupils to move according to groups to respective stations. During the activity teacher moved round the groups and monitored pupils' works.

After the pupils finished the activities and go back to their respective places (group), teacher started to discuss the results they obtained from each station. At this instant teacher only asked what happened to each group according to the station they first went. All stations gave positive results 'that heat is felt for each activity' except station 5 where the brick do not feel hot when hammered but one group said 'there is heat' but the rest of the group did not feel the heat. Then the group said that because the teacher said so when asked previously so teacher has to explain that this is true in the ideal situation. She explained that the brick they used was moist due to rain last night and that in an ideal condition and if it is not wet the heat will be given out when it is hammered. The teacher gave all the explanation for each of the activity of each station and not asked pupils to give the explanation. During the explanation of the 'heat felt at the kettle' teacher explained of the electric flow heating the kettle but did not explain about the coil heating (heating element) the kettle and also that it is the coil that heat up the water. Another explanation that teacher seemed to get mixed up was 'the heat felt at the brick' but she could have asked the pupils to feel the hammer instead. Here, teacher was trying to make a relationship between 'heat energy' and the 'hotness of the object'.

After her explanation, teacher asked pupils to answer the questions in their exercise books. The questions have been written by the teacher on a large sheet of paper and put it up on the board. Pupils copied it into their exercise books and just underline the correct answer. Teacher went round the class and look at pupils' work and helped those who did not understand. Finally, as a conclusion of the lesson, teacher asked 'what is the relationship between hotness and heat'. A pupil answered that 'if there is no heat energy they will not feel the hotness'. Then teacher concluded by saying that 'if there is heat energy it will give an effect of hotness' (to emphasise the conclusion sought). Then teacher asked pupil the source of the heat for each of the activity. Then teacher showed a transparency of the sources of heat energy. The source of heat energy shown is from electric, burning, solar,



rubbing, hammering and form chemical reactions. Then teacher asked, 'what is the most important source of energy'. Pupils answered the 'solar energy'. Then teacher continued the explanation of 'if the earth has no solar energy'. Then pupils are asked to answer questions in their workbook on the same topic. The lesson stopped here.

Observation description

Teacher's name: JZ

Date: 3/3/99

Time: 9.20-10.20

No. of pupils: 30

Topics of lesson: Plant respiration

Strategy: practical activity

Approach: guided inquiry-discovery

Setting: science room

JZ started the lesson by asking pupils to inhale and then teacher asked them how do they respire. Teacher asked what object or tools (she should have used 'organ' instead) that we use to breathe. Then pupils answered 'the lungs'. Then teacher asked 'besides human being what else use the lungs to breathe'. Then pupils answered 'animals'. Then teacher said that human and animals use lungs for breathing. Then continued saying that today they are going to investigate another respiration. Then teacher said that they know that living things are made up of human being, plants and animals. She said that earlier they have said that man and most animals respire through lungs so how about plants. 'Do plants respire?' and the whole class said 'yes'. Then teacher said, 'as we know all living things respire so plant respire' and 'today we are going to find out how plants respire'. Then teacher asked, 'does anybody know how do plant respire?', a boy answered 'through leaves'. Then teacher asked anybody else who wants to response. When there was no more response, teacher repeated the pupil earlier answer and said that this statement is a hypothesis 'that is plant respire through the leaves' and so this hypothesis will be tested. And said that this hypothesis might not be correct thus it need to be tested. Then teacher asked, 'what are you going to do to test the hypothesis' and pupils' answered that they need to carry out an experiment.

Then teacher asked each group leader to get the apparatus and material for the practical work. Teacher asked pupils to listen to her what they should take and instruct one pupil from each group to get the material. Then asked these pupils to get back to their respective group. Then teacher instructed pupils to put away all other books. Then teacher checked the materials the group should have for the practical work. Then teacher asked them to put up the material as she mentioned one by one. There was one group did not take the roots of plants. Then teacher instructed them to collect them instantly. Then teacher made the pupils to listen to her instruction. Teacher said that she would be providing them with warm water. Then she told the pupils to put the leaf into the water and observe what happened and answer the questions on the worksheet and to draw their observation on the manila card. After distributing the worksheet and manila card, teacher asked each pupils from the groups to bring their beakers to her so that she can pour the warm water for them and asked them to put it in the middle of the table. Then teacher asked them to put in the leave in the water and asked pupils to observe what they see. At this instant teacher moved round the class to monitor pupils' work. Then teacher told them if they have finished with the leaves to continue with the stems and branches. (The pupils follow the instruction as teacher instructed them step by step - as a whole class)

Then teacher asked pupils to stop their work and asked them to put their apparatus aside. Then teacher said that they have done the experiment and called a group to come forward to read their answers. Then teacher asked the other group to check their answers. Then she asked another group to answer the same questions. Then since pupils did not know how to answer the question on inference teacher explained the meaning of inference and gave the answer to this question. Then, teacher explained the meaning of stoma and told them that 'this is the way plants that live on land respire'. Then teacher asked, 'how about the plants that live in water'. Then teacher straight away explained the answers and asked pupils to give examples of plants live in water. Then teacher explained that these plants respire through the stems. Then teacher asked, 'what did you observe when you put in the branches?' and then she demonstrated again and said that 'there are air bubbles so the stem is also a place where plants respire'. Then teacher asked whether the hypothesis was correct and pupils shouted 'yes'.

Then teacher gave pupils exercise sheet and this took about 20 minutes. The questions were short answer questions related to the concept taught. After this teacher asked what conclusion can they make. A pupil answered 'that plants respire through the stoma' and teacher further explained by saying that they are found on the surface of the leaf and the stems and roots. Then teacher asked pupils to copy the notes she wrote on the blackboard into their notebook.

Observation description

Teacher's name: MY

Date: 24/3/99

Time: 10.00-11.00

No. of pupils: 36

Topic of lesson: Basic need of living things.

Strategy: Discussion

Approach: Guided inquiry-discovery

Teacher started the lesson by writing on the board the topic of the lesson. Then teacher asked pupils to refer to the textbook on the topic discussed. Then teacher refers pupils to the statement in this textbook stating that 'human being need food, water and air to live'. Teacher said that 'these needs are called basic need'. Then teacher asked pupils, 'do animals also need water, air to live?' Then using the textbook as an aid, teacher asked pupils to write (list) the name of the objects they saw in the textbook. Then teacher checked with the pupils their answers on the list of object pupils wrote down. Teacher asked pupils to tick if they have the answers and to add if they did not. Then teacher said 'you need to do some observation on the objects mentioned'. Then teacher takes the 'sun' as an example; then teacher asked, 'if you want to observe something, what do you need to observe?' Pupils answered; 'the colour', 'the shape' and 'the size'. Then teacher asked how would they state their observation of a sun. Then pupils answered, 'the sun is orange in colour'. Then teacher gave a few more examples of observations. (Here teacher tried to teach pupils how to do observations)



After this brief explanation of observation, teacher distributed some picture for the activity. Then teacher asked pupils to look at picture A, and asked pupils to make observation on the picture A. Then after this, teacher asked pupils if anyone would like to give any observation on the picture. Some pupils give a few observations. Pupils just explain the observation they saw in the picture. Teacher then tried to bring pupils to the basic need shown on the picture by asking what is the basic need that is actually shown in the picture. Pupils then responded by saying 'food', 'shelter'. But teacher did not respond to this answer but instead link back pupils to the earlier statement mentioned. Then teacher asked them to compare their answers with the statement. Then teacher asked them to say which one (the basic need) did they see in the picture. Then teacher asked pupils to look at picture B and C. Here teacher and pupils discussed the observation they saw from the pictures. Finally teacher tried to make conclusion for the pupils from the observation of the pictures.

Then teacher gave exercise for the pupils to do. Teacher wrote the questions on the blackboard for the pupils to answer in their exercise books using the pictures given to them during the discussion activity. After the activity, teacher asks if anybody can make a conclusion from the activity. A boy stated that animal need water, food and air. Then teacher responded by saying that is correct and asked the class to give the boy a clap. The lesson stops there.

#### Observation description

Teacher's Name: MA

Date: 6/4/99

No of pupils: 40

Topic of lesson: Conductor and insulator

Strategy: Practical activity

Approach: guided inquiry-discovery

Setting: Science room

Teacher started the lesson by asking pupils to refer to pupils' workbook, then asked a pupil to read the experiment written on the workbook to the whole class. (This is an introduction of what they are going to do today) Then teacher again go through all the materials that they need to use in the practical work. Then teacher wrote on the blackboard the table for the observation as has already been drawn in the workbook. Then teacher asked pupils to refer to their workbook that they have 8 materials to be tested. Teacher asked them to add a few more material to be tested on the table in their workbook. While pupils were doing this teacher moved around the class to see whether pupils have add on the materials instructed into their workbook. Then teacher asked pupils whether they have finish doing it (this procedure took about 10-12 min).

Then teacher briefed pupils on the experiment, initially teacher shows the apparatus they need to have for the practical one by one. Then teacher showed (demonstrate) how to connect the electric circuit to test all the materials. Then teacher explained how to record the observation on the table as on the blackboard. After the briefing teacher instructed representative from each group to collect the material from the back of the class which has been prepared earlier. (At this instant of collecting material pupils become very noisy, must be the excitement to do a practical work). Then teacher instructed pupils not to do anything yet after collecting the apparatus and material. He asked pupils to put all the apparatus and materials on the table. Then teacher asked pupils to check the material they have one by one.

Then teacher asked pupils to start the activity in the group by instructing them to do the practical step by step. A group seemed to be complaining that their bulbs did not light up. Teacher then moved to the group and helped them with the manipulative work. Pupils seemed to enjoy the activity but it can be seen that too many pupils in a group caused some pupils not able to handle the apparatus. The noise became so great because pupils are quarrelling over the apparatus. The activity took about 20 minutes.

After the activity has finished, teacher instructed pupils to put the apparatus on the table and stop work. Then teacher asked the groups to give result of their experiment as he tick the material that light up the bulb into the table on the board. Pupils give the answer as group by group. One group had a wrong answer and teacher corrected the group's answers. Then teacher asked them what were the material that light up the bulb and which do not. Pupils answered this as a whole class. Then teacher introduced the term conductor and insulator. Teacher gave the definition of these terms. Here teacher is giving the explanation of a conductor that is made up of *met al*. And those not made up of metal are insulators. Then teacher asked pupils to tick all the conductors and insulators in their workbook.

Then teacher referred pupils to the questions in the workbook and asked them to answer the questions. Then teacher dictated the answer twice for the pupils to be able to write it down in their book. He continued with the next question and again dictated the answer after a pupil answered it. Then teacher wrote the definition of the conductor and insulator on the blackboard in order for pupils to answer them in their workbook.

Then teacher once again explained the meaning of conductor and insulator and asked pupils to say out the conclusion of the practical work. Finally teacher asked pupils to look at a few other materials such as stone, then asked pupils to predict whether the bulb will light or not. Some pupils said yes, some said no. Then teacher asked them why it should light or not. A boy answered 'because it is not a metal'. Then teacher showed a magnet, pupils predicted it could light the bulb because it is a *met al*. The lesson stop here and teacher asked pupils to clear up their apparatus.

Teacher's name: NB

Date: 26.2.99

Time: 7.45-8.45

No of Pupils: 29 (weak ability pupils)

Topic of lesson: Animal reproduction

Strategy: discussion

Approach: Constructivism

Setting: Classroom

NB started the lesson by showing them two packages and asked them to guess what was inside each package. Then NB called up two pupils. They are then handed the package each one. They are asked to open up the package and other pupils are looking at the two pupils with enthusiasm. Pupils seemed to be interested in the lesson and shouted their guesses but none of their guesses



were correct. Then the boy and the girl were asked to unwrap the package and took out toy stuffed animals. Once the toys were taken out the class laughed and teacher asked them what animal is it. He shouted a bear, the girl shouted a turtle. Teacher asked them to go to their places and start asking pupils 'How do these animals make themselves become many?' Then pupils shouted as a whole class 'by giving birth to the young' and 'by producing eggs'. (This phase was planned as the 'orientation phase').

Then teacher felt that she tried to let pupils elicit their ideas by grouping them in five groups then give them a prepared large sheet of paper written with a table consisted of pictures of animals and the ways animals reproduce in two column; giving birth and producing eggs. Pupils were to discuss this in a group and tick the column in the way they reproduce. After pupils have finished their discussion, the group leaders were asked to put up their results on the board. She went through the answers together with pupil and corrected the wrong answers by some groups. There was an argument on how whales reproduce. This made the situation interesting. Only a boy said that whales give birth and other pupils said that it is wrong because whales are fish and fish produce eggs. Then teacher asked the boy why did he say that, he told the class that his sister told him. At this point teacher explained that all fishes produce eggs except whales. Then teacher continued explaining on the ways animals reproduce and that there are animals produce one egg or many eggs and give birth to one or many young's. Here teacher gave emphasis on mammals that are giving birth such as whale. (To teacher this is the restructuring of idea phase where pupils will change their preconceived ideas on ways of how animals reproduce).

Then teacher gave another activity — making scrapbook of the ways animal reproduce. (Here teacher assumed the phase to be application of ideas phase). Teacher distributed large sheet of paper drawn with the pictures of animals and drawing papers for each group. Then teacher instructed pupils to cut out the animals and paste it on the drawing paper according to the ways they reproduce. She also asked pupils to label the animals.

Then as a final activity, teacher tried to conclude the lesson by asking questions for the pupils to think back on the things they have learnt in the lesson. The questions were asked as a whole class. The questions were;

How many ways do animals reproduce?

State the two ways?

Give examples of animals giving birth?

Give examples of animals producing one egg/many eggs

Give examples of animals giving birth to one/many

Pupils were able to answer all the questions easily. These questions were low-level questions. This might be because teacher felt that the class is a low ability class and prepared the questions which were not challenging. Finally teacher make the conclusion by explaining the ways animals reproduce again.

#### Observation description

Teacher's name: NH

Date: 23/3/99

Time: 9.15-10.15

Topic lesson: Object that moves faster moves furthest (acceleration)

Strategy: Practical activity

Approach: Guided inquiry-discovery

As the pupils came in late for 15 minutes, teacher skipped the introduction part and she started by dividing the groups into 4 groups. After this has been done, the teacher wrote on the board the table they need to copy into their exercise book for the recording of the activity. Then teacher monitored the class by going around to look at pupils' work. Then she instructed them to write the name of the pupils in their group into the exercise book.

After the task has finished, she started explaining the activity they are going to do. She explained how to use the stopwatch briefly and how to measure the distant they are going to run. Then she instructed the pupils to the field. In the field pupils started measuring the 30 meters distant they need to run. Teacher played the role to start each group to run (I think this is to make sure everybody finish on time). But I could see there was problem in using the stopwatch by some pupils, which made some pupils to rerun. The activity took about 30 minutes and teacher instructed pupils to go back into their classroom.

Once in the classroom teacher asked pupils to calculate the acceleration (the theory has been taught in earlier lesson, according to teacher). While pupils were calculating the acceleration, teacher wrote some questions on the board for the pupils to answer in their exercise books. (Since this is to be used for the purpose of the experiment test so teacher said that she would not discuss the answers with the pupils because she need to take the mark for the test). Then pupils continue with answering the questions.

During the pupils were working on the calculation teacher intervened in giving the concept of acceleration.

Then finally teacher asked pupils to finish up their work and send it to her since it is going to be use for the test. The lesson ends here without any conclusion from teacher or pupils.

#### Observation description

Teacher's name: NU

Date: 22/2/99

Time: 9.40-10.40

Topic of lesson: Food Web

Strategy: discussion

Approach: Guided inquiry-approach

As an introduction teacher used a simulation. She called out seven pupils in front of the class to use masks of animals and ask each one to make the sound of animals they are acting. Then teacher asked the class to name what animals their friends were acting. Then teacher asked pupils to make a food chain from the animals acted out. This is done verbally and pupils hold hands to show the food chain. Then teacher explained the term of food chain.

After the activity of the simulation, teacher asked pupils to discuss the food web in a group from the simulation activity and write it out on a sheet of paper. Then teacher asked each group leader to draw their food chain on the blackboard. Then teacher went through each group results and correct pupils mistake of the food chain. After this activity teacher asked pupils which animal get the most food and pupils answered the eagles. Then teacher asked what happened if there was no grass, pupils said there won't be any food chain because there is no 'producer'.

Then teacher draws pupils' attention to the OHP. Teacher showed a transparency of 'habitat in a pool'. Then teacher asked if anybody could make a food chain from the picture. Then teacher asked how many food chains could be made from the habitat in the pool. Pupils answered 2 food chain. Then teacher showed another situation and asked each group to predict the number of food chain from the situation on the transparency. After predicting this teacher asked them to discuss in a group and write down the discussion results on the large sheet of paper provided. Teacher asked them to write down as many food chains as they can.

After the activity, teacher asked representative from each group to present their discussed result. Each groups' representative went out and read their result to the whole class. Then teacher compared the group prediction of food chain earlier with the ones they have after discussion. Then teacher concluded that they can make seven food chains from the situation the most and all their predictions were wrong. Then teacher explained that they would be able to make a food web from the combination of the food chain they have stated. Then teacher asked them to copy the food web into their exercise book and also the food chain they have discussed.

Then teacher asked pupils to sing a song teacher has prepared related to the topic they have learnt. Then teacher asked pupils to sing the song group by group. Pupils seemed to enjoy this session. Finally teacher asked some questions regarding the lyrics from the song and the lesson ended here.

#### Observation description

Teacher's Name: SH

Date: 31/3/99

Time: 12.00-1.00

No. pupils: 42

Topic of lesson: Light travel in a straight line

Strategy: Practical activity

Approach: guided inquiry discovery

Setting: science room

Teacher started the lesson with a question, 'Why is light important?' Teacher asked pupils to put up their hands and answer as individual (which sometimes do not happened in other observations). Then a pupil responded 'if there was no light it would be dark'. Then teacher asked any other answers but not waiting for responses she immediately added, 'light can brighten up the environment'. Then teacher asked, 'is there light at night', then pupils answered 'yes', but teacher immediately say that it is the cause of the moon's light but not very bright compared to in the day. Then teacher asked pupils again, 'where do you get the light?'. Then a pupil answered, 'from the sun'. Then teacher asked any other source. Pupils responded from the moon, then teacher corrected that the moon do not give out light, she asked them to look back at their year 4 topic on this. Then teacher continue again saying 'something that we need to light up', to this pupils' responded it as 'fire'. (Teacher tried to seek for the 'right' answer). Then teacher concluded that all these are called sources of light. Here, teacher was explaining that light is a form of energy and that object that give out light is a source of light. Then teacher told them that today they are learning about light characteristics. And that they are going to some practical work to see the characteristics of light.

Then teacher started distributing the task sheet for everybody. She asked pupils to refer to the task sheet, then explained the apparatus they need as stated in the task sheet and teacher asked pupils to follow the instruction in the task sheet when they are doing the activity. Then she read the instruction on the task sheet for the pupils. Then teacher called up group leaders to get the apparatus from her. Then pupils started the activity in a group and teacher moved around the class to monitor the pupils' work. During the activity, teacher told the class that everybody has to be involved in the activity and do the observations together. Teacher was also seen helping pupils to light up the candle. Teacher reminded pupils during the activity by telling them to make the hole in a straight line in order to see the light. Then after sometime teacher asked them to refer to the task sheet and refer to step 3 and again teacher read it to her pupils. Then teacher asked each group whether they have finished.

After the children have finished the activity, teacher instructed them to send all the apparatus to teacher's table. Then teacher asked them to write the answers first before discussing the questions on the task sheet in a group. Then a boy was called up to present his group's observation as stated on the task sheet. Then teacher corrected his sentences of observation. She called up every group but for every group she corrected the pupils way of answering. She gave feed back that all observations were correct. Then she continued to the next question. When pupil's answers were incorrect teacher did not say so but then she gave her version of answer. Then she tried to explain this by using a 'torch-light' and showed that if blocked the light cannot be seen and this is because light travel in a straight line. (Here it can be seen that teacher will only make confusion to pupils where pupils would think that light will only travel through holes). Teacher continued discussing the answers with the pupils and giving and dictating the correct answers. Then teacher asked pupils to make a conclusion and asked a group to give their conclusion. Then she asked the whole class to say out the conclusion. Finally teacher asked them about the variables in the activity (serves as an addition to process skill requirement).

#### Observation description

Teacher's Name: SS

Date: 10/3/99

Time: 9.30-10.30

No of pupils: 33

Topic of lesson: Basic need for plants

Strategy: practical activity

Approach: Guided inquiry-discovery



Teacher started the lesson by asking a question, 'what did you do during recess time'? Pupils answered, 'eat and drink'. Then teacher said that the most frequent thing they always do is eat and drink during recess. Then teacher asked pupils, 'why do you need to eat and drink?'. Pupils responded by saying 'so that our body is healthy'. Another said that it would not make them go hungry. Then teacher asked why do they need to drink, pupils answered so that they won't be thirsty. Here teacher is directing pupils to see the basic need of human being. Teacher tried to link this with the basic need of plants. Before this teacher asked questions on group of living things. Then teacher told pupils that plants are also living thing and have basic needs. Then teacher showed a transparency 'a picture of a rat eating bread'. Teacher asked, 'what is the rat doing'? Pupils answered that the rat is eating bread and teacher continued by saying that animals need food to live and so do the plants. Then teacher said that plant cannot find food and asked 'so how do plants get food'? Then a girl answered, 'plants need sunlight to live'. Then teacher asked, 'why do plants need the sunlight'. Another girl said, 'so that plant can live healthy with sunlight'. Here teacher explained that plants make food and most green plants can make food and teacher continued with the term 'chlorophyll' to make food and need the sunlight to make food. Then teacher asked 'what else do plants need to live?'. Pupils responded by 'saying, oxygen, water and minerals'. And teacher asked for one more but pupils did not respond and teacher finally mentioned 'carbon dioxide'. (This event showed that teacher has already given most information about the 'photosynthesis concepts' which is not required in this lessons of introducing the basic needs of plants even though there is a relationship but should be discussed in a much later stage)

Then teacher told pupils that they would be doing experiment to investigate the basic need of plants. Teacher asked group representative to get apparatus. But before that teacher gave an instruction. Teacher briefed them what apparatus they need to use for the experiment. Teacher also continued briefing pupils on the method they should do in the practical activity. After the briefing teacher called up the pupils to come and get the apparatus one by one (due to a very difficult class to control). Then teacher reminded pupils to put in the water on the cotton wool in 'petry dish A' and no water in 'petry dish B'. (The whole time of this activity pupil became very noisy and uncontrollable). Teacher monitored the pupils work. When pupils have finished preparing the petry dishes teacher said that they would need to observe the petry dishes for a week. Then teacher asked pupils to predict what will happen in petry dish A and B within a week. Then teacher asked them to record the observation for the day in a table (prepared by teacher) and continue to record the observation for a week. Teacher guided pupils to write the observation in the table for today's observation for 'petry dish A' and asked pupils to discuss in their group for recording observation in 'petry dish B'.

After this activity, teacher distributed an exercise sheet to every pupil. Then teacher asked them to refer to the exercise and read the question together with pupils. The question was on interpreting a graph of height of plants that grow in four weeks. Pupils seemed to be interested in the question and everybody seemed to be focusing in the question (noise level reduced during this activity). One of the questions were on the science process skills of making interpretation why the heights of the plants differ even though they were planted on the same day. Teacher tried to guide pupils to come to the answer, 'plants differ in height due to amount of water the plants received'. (Here teacher was trying to get pupils to give the 'right' answer — according to his predetermined answer) Teacher then asked pupils to write down the answer.

Then teacher distributed another exercise sheet. Then teacher discussed the question on the exercise sheet. Teacher asked a pupil to read it loudly for the class. The question is on making inference, 'why was there a difference between the two plants?' Then teacher tried to ask pupils to come up with their inferences. Teacher had difficulty in trying to get pupils to give their answers. Then teacher asked another questions on predicting and again teacher had difficulty in trying to get pupils to come up with the answers he wanted. Finally teacher gave the answer for pupils to write on the exercise sheet.

(In my experience observing this lesson, teacher was trying hard to get pupils to be involve in the activity and discussion but as the class was a less able class and he was having a lot of class control problems. Children seemed to be very restless and some not paying attention and making a lot of noise. Teacher was trying his best to control the class. However, since the activity need a week's observation, the exercise given were on science process skills and this become an arrange appendage of the skills)

#### Observation description

Teacher's Name: ZA

Date: 24/2/99

Time: 11.05-12.05

No of pupils: 33

Topic of lesson: Food web

Strategy: discussion

Approach: Guided inquiry approach

Setting: Class room

Teacher started the lesson by asking questions on the previous lesson. Teacher asked a pupil to write one example of a food chain on the blackboard. Then teacher told them that the day lesson is 'a continuation of food chain' that is 'food web'. Then teacher said that they would be discussing food webs on certain habitats. She continued by saying since they cannot go the habitat so she wanted them to imagine that they are scientists on a mission to find out the food web on the habitat assigned to them. Then teacher asked group leaders to come and chose the task card of the habitats.

Teacher asked them to discuss the task as soon as they get the task card. She then distributed manila cards for pupils to draw their food web. Teacher monitored the group working and move from group to group. Then problem arose in the lesson, pupils cannot finish the task as they did not write the word but instead they drew the animals. So this took a long time and until the end of the lesson pupils did not do any discussion but still trying to finish the drawing and some were trying to colour them too. I feel that teacher could have emphasised to pupils that they should use the words instead of drawing pictures. So the lesson end without any discussion or pupils presentation or conclusion.

#### Observation description

Teacher's name: DZ

Date: 8/3/99

Time: 9.20-10.20



No. of pupil: 30  
Topic of lesson: Conductor and insulator  
Strategy: practical activity  
Approach: Guided inquiry discovery

Teacher started the lesson by telling pupils that the topic was still about 'electric flow'. And that today they were going to learn a topic on 'conductor and insulator' in the form of 'solid'. Teacher told them that they would be doing a practical activity for this topic. But before that teacher asked pupils some questions on the previous lesson. Teacher asked pupils 'What are the basic components to make up an electric circuit?' Some pupils responded by saying 'batteries, wires, switches and bulbs'. Then teacher continued by drawing the complete electric circuit diagram on the board. Then teacher showed them that the wire was insulated by rubber made material. Then teacher asked, 'why is it so?' Then a pupil answered, 'to protect us from electric shock'. Then teacher continued by saying, 'if we are using batteries the power is small, but if we get electric shock from electrical power such as at home the power is much bigger'. 'If they are any part of the wire is exposed and touch any woody surface, a fire will start'. Teacher continued by saying that the rubber covered the electrical wire and if they change the wire with wood, what will happen to the bulb. A pupil answered that the 'bulb will not light'. Then teacher asked, 'why?' A pupil answered, 'there was no electric flow' with teacher guide. Then teacher explained that the wood is an insulator and so is the rubber covering the wire. Then teacher wanted to define the meaning of insulator and conductor but told pupils he will not tell them but want them to understand it through the activity.

Then teacher started to distribute task card to each group and asked them to refer to the task card while briefing them on the instructions on the task card so that they would know what to do. Teacher told them he would provide all the components later. Then he briefed them to record their observation on the table provided. Then teacher asked each group leader to come and collect the apparatus from him. After distributing the apparatus, teacher once again asked for pupils' attention to the blackboard to explain again how to make the circuit to test the material whether it's a conductor or insulator. Then teacher instructed them to start work. While pupils were doing the activity teacher monitored pupils' work and helped those who could not connect the electric circuit. The activity took about 20 minutes.

Then teacher instructed pupils to stop work and sent back all the apparatus and get ready for discussion of their results. Then teacher called up a group and he wanted them to tell the materials that were able to light up the bulb and then another group only on materials that were not able to light up the bulb. Then teacher asked the other groups to check whether their answers were similar to the groups presenting the results. Since there was no difference, teacher continued with the explanation that those materials that light up the bulb are made up of *met al*. Then he continued by saying those not made up of metal cannot light up the bulb. Then teacher asked one group to give answer on a question in the task card. This continues for each question and teacher corrected the wrong answer pupil gave and asked them to write the right answer in the task sheet. Then teacher gave the conclusion on the activity on the conductor and insulator. Then teacher ended the lesson by giving pupils another exercise sheet to do until the end of the lesson. Before pupils started to answer the question, teacher again briefed them how to answer the questions. Then after the short explanation on how to draw the complete circuit as shown on the blackboard and how to answer the questions teacher asked pupils to start the work. The lesson ended here.

Observation description  
Teacher's Name: AA  
Date: 18/3/99  
Time: 12.05-1.05  
No. Of pupils: 46  
Topic of lesson: Light characteristics  
Strategy: practical activity  
Approach: Guided inquiry approach  
Setting: classroom

Teacher started the lesson by asking a pupil to switch on the light and asked pupils to imagine what will happen if she cover the light with a big piece of clothe. Pupils answered that the light will be covered and they cannot see the light. Then teacher showed a straw and asked them if she bend the straw can they see through the straws' hole. Then a pupil suddenly said 'light travel in a straight line'. Then teacher said, 'is it true that light travels in a straight line?' She continued saying that they are going to prove that light travel in a straight line in the practical activity. Then teacher tried to link this to the concept of light from the moon, that during full moon, they can see that the light from the moon. Then she asked, 'is it the moon giving out the light?' Pupils answered 'no, the light is from the sun and the moon reflected the light to earth'.

After the introduction, teacher began to make groups for pupils and asked them to go to their respective groups. Since it is in a classroom so she asked pupils to group themselves with the pupils sitting nearby so as to save time. Then she distributed the apparatus and material. Each group was given three hard pieces of paper of same size with holes. Teacher asked them to label the papers as A, B and C. Then she distributed the task sheet to each group. Then teacher drew the procedure they have to do on the blackboard. Then she asked them to follow the instruction on the task sheet. While pupils were doing the activity, teacher moved around the groups to make sure that pupils were following the instructions. Then she continued telling them to carry out the second step. Pupils were making a lot of noise during the activity. It could be seen that everybody wanted to try out the activity but the apparatus was limited, so some pupils could be seen quarrelling over this. Again during the activity, teacher reminded them to do the second step.

Then teacher distributed the exercise sheet on the activity and pupils were asked to discuss their results and record it on the exercise sheets individually. Then teacher referred pupils to the exercise sheet and asked them to answer all the questions for the activity A while reading it to them. Then pupils continued with the work. Then when she saw that pupils have finished doing activity A, teacher brief them on activity B. She then referred them to the task card on activity B and read them to the class. Then pupils carried out the activity in their group. Teacher moved around the groups and monitored pupils' work.

After pupils have finished the activity, teacher asked them to discuss the result and the exercise sheet in a group before the whole class discussion. Then teacher discussed the result with them; pupils answered all the questions correctly. Then there was a question on applying the concept in everyday objects that all pupils did not know the answer. So teacher gave them the answers



to the questions and explains how the objects use the concept. After the discussions teacher asked pupils to send back all the apparatus to teacher's table.

Observation description

Teacher's Name: BA

Date: 31/3/99

Time: 7.45-8.45

No. Of Pupils: 31

Topic of lesson: Temperature

Strategy: Practical activity

Approach: Guided inquiry discovery

Setting: science room

Teacher started the lesson by asking two pupils to role-play as mother and a sick daughter. Then teacher asked the whole class what was the message of the act. So teacher asked what instrument that need to be use to measure the temperature. Pupils answered as a whole class, 'thermometer'.

Then teacher asked, 'what is the normal body temperature'. For quite some times when there was no answer from the pupils, teacher said that before she discusses on this they would be focussing first on the day's lesson. Then teacher told the class that the topic of the lesson is on 'temperature'. Then teacher asked pupils, 'what is temperature?' Teacher tried to direct pupils to get to the 'right' answer of 'what is temperature'. Here she tried to make pupils to define the meaning of temperature. Then teacher wrote the definition on the blackboard. At this phase teacher explained the instrument to measure the temperature. Then teacher introduced two types thermometer: clinical and laboratory thermometer. Then she explained the unit use for measuring temperature. She explained the methods to read the thermometer by using the aid of transparency in explaining this. Teacher showed pupils the parts of the thermometer, the liquid use in the thermometer and the correct reading of temperature using the thermometer. Then she explained the normal body temperature of human being.

After this explanation, she told pupils that they would be measuring three types of different water temperature. Teacher explained the experiment to them briefly. She also reminded them the safety measure in handling thermometer and warm water. Group leaders and assistant were called up to collect the apparatus and material from her and this was done group by group. When all the apparatus have been distributed, pupils were asked to label the beakers. Then pupils carry out the activity following the instruction on the task sheet while teacher monitored pupils' work.

When all pupils have finished the activity, teacher instructed pupils to keep all the apparatus back to the original place they collected them. Then teacher together with pupils discussed the results of the practical activity as a whole class. (Here teacher gave a wrong misconception of controlling the variables — teacher understanding of science process skills was not correct at this phase). The whole of the discussion session was observed as teacher directed (leading the answer) approach for the pupils. Then teacher asked pupils to make conclusion from the activity. The questions given were very low level. Then teacher gave another set of exercise questions for pupils to do for the remainder time. The lesson ended here.

Observation description

Teacher's name: NB

Date: 4/3/99

Time: 11.05-12.05

No. of pupils: 41

Topic of lesson: Magnetic material

Strategy: Practical activity

Approach: Constructivist approach

Setting: Science room

As introduction teacher showed pupils pictures of two birds and picture of tree branches. Then teacher asked pupils, 'do you think that both birds are able to stand on these branches? (referring to the picture) Pupils did not see at the back of the picture, has been pasted with a magnet and on one of the bird has been stuck with a paper clip. So pupils should see that only one bird should be able to stand on the branches. Then teacher asked pupils to predict why 'the bird' was able to get stuck to the branches on the picture. Students give a lot of guesses and one pupil guessed correctly.

After the introduction, teacher told the pupils that they were going to learn about materials attracted by magnet and materials that cannot be attracted by magnets. Teacher told pupils that she will be distributing a paper cup filed with some materials and that they need to share it in a pair. Then teacher started distributing the materials. Teacher asked pupils to check the materials as she mentioned them out. Then she asked pupils to listen for instruction. Teacher asked them to do 'prediction' on the materials attracted/not by magnets and write them down on the worksheet provided before proceeding with the activity. While pupils were doing the activity, teacher monitored pupils work and making sure everybody was involved.

After prediction and recording of the prediction, teacher then asked their prediction and when this has been done, teacher distributed magnet for each group to test the materials and compare the result with their prediction. Then teacher discussed the results with pupils. Teacher asked one by one the material tested and pupils answered as a whole class whether it is attracted by magnet or not. When this has been done teacher asked pupils to refer to the questions written on the worksheet and asked them the answer. Once pupils have answered them as a class, teacher asked them to write them on the worksheet. This was done together with pupils and following question by question. (This is another example of teacher directed/instructed learning). Then once pupils finish the questions, teacher asked for attention and asked pupils to separate the objects attracted and not attracted by



magnets. Here teacher wanted them to see the materials attracted by magnets are made of iron and those not attracted are not made of iron. After explaining this, teacher directed pupils to look back at the question on this concept and asked them to write down the answer. Here teacher tried to explain the concept of magnetic materials and non-magnetic materials. Then teacher distributed another worksheet and wanted them to move as group and she wanted them to look for five objects that are attracted by magnet and five not attracted by magnet in the science room. Then teacher asked them to start moving and carry out the activity and record them in the worksheet provided. After this activity, teacher asked again pupils to represent their results. Then teacher tried to clarify with pupils the concept of magnetic material and material made of iron as magnetic materials as a conclusion. Teacher asked pupils to complete their answers, then continued with the other worksheet and this was done together with pupils to answer the questions. Then teacher asked pupils those who have finish completing the worksheet to send in the materials. The lesson ended here.

#### Observation description

Teacher's name: NU

Date: 15/3/99

Time: 9.45-10.45

No. of pupils: 31

Topic of lesson: Conductor and insulator

Strategy: Practical activity

Approach: Guided inquiry approach

Setting: science room

Teacher started the lesson by explaining to pupil the meaning of controlling variables - 'constant', 'responsive', and 'manipulative'. Then she continued with explaining the meaning of 'hypothesis' and how to make a 'hypothesis'. Here, it can be seen teacher found difficulty in explaining to pupil to formulate a 'hypothesis'. Teacher give an example first of a hypothesis and then change it to a different one when she found it not suitable and at this instant it can be seen that pupils were confused. It was seen that she wanted to use a general 'hypothesis', which only confused her pupils. Her example of the hypothesis was; 'the more effective the teaching of a teacher, the cleverer the pupils'. Once she saw that pupils were confused, she changed it to a different hypothesis, which also seemed not really understood by pupils. After explaining these, teacher explained that they were going to identify the materials which are 'insulator' and which are 'conductor'. Then teacher asked each group to formulate their hypothesis. Then teacher instructed them what they should do in the experiment and then distributed the task sheet. Then teacher distributed apparatus and materials. As the apparatus are limited, teacher made the number of group smaller and thus the number of pupils become bigger in a group. When all has been ready teacher instructed pupils to make prediction first before testing the materials while monitoring pupils during the activity. Then after 10-15 minutes pupils finished their work, teacher instructed them to keep and wash all the apparatus and clean their table. After all the groups have finished cleaning up, teacher instructed pupils to discuss in their group, 'what inference can be made in the activity'. Then teacher instructed them to answer all the questions in the task sheet. Then she asked them to write down the variables and make conclusion of the activity on the task sheet.

After the pupils finished discussing the questions on the task sheet, teacher asked them to get ready for the presentation. Then teacher called up a group to present their result. Others were asked to listen to the presentation. A representative said that their hypothesis was 'If there is no electric, the bulb will not light up'. Their inference was 'the bulb will light up when there is an electric flow'. Then he presented their variables; constant - battery and paper, manipulated-materials, responsive-bulb. Then their conclusion was 'the bulb would not light up when there was no electric flow'. (Here it can be seen pupils misconception of the whole activity). After the presentation, teacher asked whether anybody has any question and is there any mistake in the group result. Since no responses from the pupils, teacher asked another group to present their results. Then another group representative was called up. A girl came out and presented her result. Her hypothesis was; 'if switch is on, the bulb will light'. Here, teacher immediately asked the class is it correct, then they said it's wrong and she told them that is the observations, but teacher at this point did not correct the 'hypothesis' but asked the girl to continue with the next questions. Her inference was; 'the bulb light up because it is attached to metallic materials'. Then she continued with all the other answers, which were all wrong on the controlling variable and conclusion. Then teacher said that since time was not enough and not all groups would be able to present so she told them that she would now make conclusion for the lesson. Then teacher asked pupils to go through with her the task sheet. Firstly, she asked them what were they trying to investigate. A boy said, 'materials that can make electric flow and those that can't'. Then she said that some of the hypotheses given were right and some were wrong. Then she asked a group to make a 'hypothesis'. A boy answered, 'if there is electric flow, the bulb will light up'. Then teacher said that this is a correct hypothesis. Then teacher went through all the materials, whether they light up the bulb or not. At this point, teacher asked them to correct their wrong answers. But there are certain material that should light up the bulb but did not and this happened to all the groups, so teacher told them they should see the bulb light up because all these materials able to let electric current to flow through it. (water, lime water, salt water, vinegar, soy sauce) Then teacher asked them why is it that it did not light up the bulbs, pupils seemed to respond by saying, 'maybe the batteries were weak or the materials were exposed too long). So teacher explained that all these materials should be able to light up the bulb. Then teacher asked them the inference; pupils answered that the light will light up if there is an electric flow. Then she continued with the variables; she asked them what is the constant; pupils responded by saying batteries, paper clip, wire, bulb, batteries holder. Then teacher said those that they use the same all the time in the activity would be a constant. Then she asked for manipulative variables; then she told them the types of materials use. Then the responsive variable is the lighted bulb. Then the questions on classification of the conductor and insulator materials form the activity. Then she asked pupils to give the conclusion. A boy said that the bulb will not light if there is no electric flow, then teacher asked another pupil, he responded by saying all the materials made of metal will light up the bulb. Then teacher asked what about the liquid. Then teacher told him all these are conductors, so she helped him by saying all conductors are able to light up the bulb. Then she asked another boy. He said, 'the bulb will not light up if there is no electric flow'. Another boy concluded, 'the bulb will not light up if it is connected with an insulator. Here teacher did not give feedback to his answers and just told the class the lesson ended there.



**Observation description****Teacher's Name:** SS**Date:** 16/3/99**Time:** 12.05-1.05**Topic of lesson:** Plants and animals need air**Strategy:** Practical activity**Approach:** Guided inquiry approach**Setting:** Science room

Teacher started the lesson by asking pupils to close their nose with their hands and then asked them how do they feel. Then pupils answered they cannot breath. But teacher continued asking some individuals the same question. Then teacher asked when they close their nose what cannot enter through their nose and pupils said 'air'. Then teacher corrected this by saying oxygen. Then teacher continued by saying human being breath air that contains oxygen. He continued by saying all living things need oxygen or air to live. Then he told pupils that last week they have learnt about the basic need of living things. He recalled the experiment they did on planting seed to look at the need of water to live. Then teacher told the class that today they are going to see whether plants need air to live.

Then teacher explained about the practical procedure that they were going to do. Since there are not enough apparatus, teacher re-group pupils to make a smaller number of groups. Teacher distributed two plastic glasses for each group to label as A and B filled with seeds. Teacher instructed them to do this first. Then teacher asked one pupil in each group to take glass B and add some pipe water in the glass and add some cooled boiled water into glass A. (this is done step by step with the pupils-directed instruction). Then, teacher asked them again what is in glass A. Then teacher asked them to pour some cooking oil to glass A. (oil has already been prepared in syringes). Then teacher asked them to observe glass A. Pupils said that there is a layer of oil in glass A. Then teacher instructed everybody to sit at their places.

Then, teacher reminded pupils again that they have ordinary water in glass B and cooled boil water in glass A. Then, he asked the class to predict what will happened to the seeds in glass A and glass B. Pupils responded by saying, 'the seeds in A will not germinate and seeds in B will germinate'. Then teacher asked, 'why is this so? Pupils said that the layer of oil would stop air from getting into the water. Then teacher asked what did the oil do. Pupils said that the oil stop the oxygen from coming in the water. Then teacher explained that the boiled water and the oil stop the oxygen from entering the water and that plants need oxygen to live. (here teacher gave a wrong misconception of the boiled water not permitting the air to get into the water and not that oxygen in the boiled water has been removed.)

After the explanation, teacher distributed exercise sheet for them to do. Teacher instructed them to read the exercise questions first. He asked a pupil to read the question to the whole class. He read again the question and asked them to make a 'hypothesis'. Then a boy shouted to the teacher 'what is hypothesis'. But teacher ignored the question and asked them to do a hypothesis. Then teacher said to refer to the activity they have done and try to link it with the question. After some time pupils said they cannot do the hypothesis. Then teacher told them it was okay since they have just heard the term. He insisted by asking pupils who are able to make a hypothesis. Then teacher said they know that seeds will germinate when there is oxygen. He asked them to link the germination with the factor of oxygen. Teacher asked pupils, 'what are other factors that need to help germination of seed'. Then teacher asked them to recall the previous activity they did. Then pupils responded by saying 'water, sunlight, chlorophyll and carbon dioxide'. Then teacher guided pupils to make the hypothesis by helping them with the statement. But pupils do not seem able to make the hypothesis. Then teacher said the hypothesis is 'the more water, oxygen and sunlight the seeds get the more able the seeds would germinate'. Then teacher continued with the next question and asking pupils what were their answers and teacher guided pupils to answer all the questions during this session. Then teacher asked them to make a conclusion from the discussed experiment from the exercise sheet. (From this activity, the teacher has already given the result of the practical activity they did. Teacher should have not make the conclusion but to do it later after the experiment has been kept for a few days and come back to discuss it again)

After the above activity, teacher asked pupils to look at another activity. Teacher has prepared two glasses of water with mosquitoes larvae and he labelled them for pupils as glass A and B. Then teacher instructed pupils to add in oil to glass A. Then some pupils shouted the larvae died. But teacher still asked to predict what will happened to larvae in glass A. But pupils shouted the larvae has died once they put in the oil.(what actually happened was pupils push in the oil from the syringe too fast that it hits the larvae, teacher could have instructed them to put in the oil slowly) . Here, at this moment teacher did not asked them what has happened but instead go on distributing another task sheet of the activity on the larvae. (The teacher has difficulty in disciplining this less able class). Then teacher asked pupils to refer to the task sheet. Teacher discussed the questions on the task sheet together with the pupils. Here it could be seen teacher guided the pupils to answer the question. Here again teacher shouldn't have asked pupils to make the conclusion yet as they are asked to predict their activity on the animals (larvae) which they have to keep for a few days. But here again teacher asked pupils to give conclusion. Then after this discussion teacher gave another exercise sheet as homework. The lesson ended here.

**Observation description****Teacher's name:** ZA**Date:** 3/3/99**Time:** 11.10-12.10**No. of pupils:** 31**Topic of lesson:** Heating elements**Strategy:** discussion**Approach:** Guided inquiry approach**Setting:** classroom

Teacher started the lesson by asking pupils to recall the previous lesson on the heating elements and then teacher asked what apparatus use heating elements. Pupils answered as a class, electric kettle, iron, hair-drier. Then teacher showed a kettle in front of the class. Here teacher was trying to ask pupils where do the heat come from. Then teacher asked a pupil to look into the kettle



and see what is in the kettle. Then pupils said 'coil', then teacher corrected this immediately by saying the 'heating element' and then she continued by asking where do the heating element gets its heat then pupils shouted – 'from the electric current'. Then teacher said that today they are going to do an activity. Then she instructed pupils to refer to their science textbook (She was one of the two teachers using textbook for the pictures they have on the textbook) and to refer to certain page. There is an 'activity 7' in the textbook. Then teacher instructed pupils to read the 'activity 7' and what they should do. Then teacher asked whether they understand the instruction and pupils said they understood. However teacher still briefed them what they should do. Teacher said that they should record their observation in a table form. Then teacher said that she would show them the format of table they need to do on the board. Then she told them she would be distributing large piece of paper for pupils to record their observations. She told them to identify what are the apparatus in the kitchen as shown in the picture in the textbook using heating elements and those do not.

Teacher asked each group leader to get the paper and a meter rule (to draw the table on the paper provided). Teacher drew the table on the board. Then teacher instructed the pupils to copy the table as on the board and write down all the pictures of electric appliances as seen on the textbook. Pupils are asked to discuss this in group and tick appliances that use heating element in the table. Then teacher said those who finish their work faster would get bonus mark (to give pupils incentives and to motivate pupils for competition spirit) While pupils were discussing, teacher moved around the groups to monitor pupils work. After 20 minutes, one group managed to finish and put up their result on the board. After all groups have finished the work every group put up all the result on the board. Then teacher said that they would check the group presentation. And each group was given marks on the appliances pupils identified as electric appliances. Then teacher checked the result for each group the appliances using the heating elements and different marks are given for this.

Then after checking pupils' answers, teacher corrected pupils' answer of a blender using the heat element. Teacher explained that the food when blend give out some heat but it is not the heating elements. Then she explained that a refrigerator and blender do not use heating elements. Then teacher announced the group with the most marks. Then teacher said that the conclusion is that all apparatus with heating element will give out heat. Then teacher said that the effect of heat in the apparatus is important for their life. And then teacher gave examples of rice cooker using the heat to cook the rice. The lesson ended here.

#### Observation description

Teacher's name: DZ

Date: 22/2/99

Time: 9.15-10.15

No. of pupils: 36

Topic of lesson: Changes of electric energy

Strategy: practical activity

Approach: guided inquiry discovery

Teacher started the lesson by telling them the topic of the day's lesson. Then teacher said that he wanted them to recall the last week topic on sources of electric. He asked pupils to give examples of the sources of electric. Then pupils' responses included batteries, generators, and accumulators. Then teacher asked anything else, when pupils did not response teacher added some more of the examples. He then explained that these sources of electric provide electric current. Then teacher explained that the electric current is use to work the electric appliances. Then teacher said that the electric appliances would change the electric energy to change their function. Then teacher asked examples for uses of batteries. Then pupils said, 'in torchlight', then teacher explained the changes of electric energy in the batteries through questioning pupils the changes of energy in the torchlight. Then teacher said that he would let them do a practical activity to see the changes of electric energy. Then teacher distributed the task sheet and called up group leaders to collect the apparatus and materials. Then teacher instructed pupils to listen to his instruction on the practical activity. He explained to pupils what they should do for practical activity 1 and 2, while pupils referring to the task sheet. Then pupils are instructed to carry out activity 1 and 2, 3. Teacher monitored pupils' work by going round the group and checking pupils' activity. During the activity, it seemed that teacher have to do all the connecting of the electric circuit for each group. Then for activity 2 where pupils should make coils from the copper wire was also done by teacher for all the groups. It showed that pupils do not have good manipulative skills and needed help from teacher. While helping pupils with the activity, teacher reminded pupils to write down their observation on the task sheet. Then when the pupils seemed to have finished the activity teacher asked them to dismantle the apparatus and send them back to teacher's table. He wanted them to check their result and asked a group to read their answers for the class. Every group had the same answers. He continued asking the questions on the task sheet for the discussion of the result. Here teacher continued with a question not given in the task sheet since he was trying to bring pupils to the concept of changes of the electric energy to heat energy. Teacher gave explanation to pupils on the changes of electric energy. Then teacher referred them to activity 2 and asked what result did they get. Each group was asked of the result they obtained. Teacher explained the different results obtained. Then teacher continued with the discussion of activity 3. Then asked a group to give their result. Then, teacher again did the explanation for the changes of energy in the activity 3. Then teacher said he wanted to discuss how to apply this concept in the everyday use. Here teacher explained about the electrical appliances at home. Teacher explained of the function of electric appliances and the changes of energy and the use of it in everyday life. Then teacher asked if they have any questions. Since there was no questions from the pupils, teacher distributed exercise sheet for pupils to do. Teacher explained briefly that the questions on the exercise sheet are based on the practical activity they have done and asked them to answer the questions and the lesson ended there.

#### Observation description

Teacher's Name: JZ

Date: 19/3/99

Time: 11.05-12.05

No. Of pupils: 35

Topic of lessons: Movement of animals

Strategy: discussion

Approach: guided inquiry approach

Setting: Science room



Teacher started the lesson by asking pupils a question, 'How can I move from where I stand here to the door?' Pupils responded by saying, walking, running, crawling. Then she said all these are called movements. Teacher called up a pupil to role-play movements of animals and the others guess the movements acted out. She explained that animals have different types of movements and that today they are going to learn the different types of animal movements. She then distributed a copy of picture of different types of animals to each group. Then teacher told them their task was to classify the picture of the animals according to their types of movements and paste it on the drawing paper provided by teacher. Then teacher instructed them to do it in a group. She briefed them what they need to write on the drawing paper and show them how to do the classification on the drawing paper.

As pupils were doing their work, teacher monitored pupils' work and move round the groups to make sure everybody was involved in the activity. Then teacher found a group that did not do the activity. This was all boys group, it can be seen there was no co-operation in the group as only two pupils were trying to do but seemed do not know what they should do. When it was time to finish the work teacher found out that this group could not manage to finish their work. Then teacher asked pupils to stop work either they have finish or not. She called up all group leaders and presented their group's product to the whole class. Then teacher went through each group outcome. Here teacher do the explanation of each group not the group leader (this shows teacher authoritative attitude) She did all the explanation and giving marks for each group.

After this has been done teacher instructed pupils to look at the blackboard as she is writing on it a concept of the types of movements of animals as a conclusion for the lesson. While explaining she asked the examples of animals of each type according to movement. She continued explaining the physical characteristics of animals with certain movements. At this phase teacher gave all the information to pupils and it is a one way approach.

Finally after this phase, teacher asked pupils to copy the notes on the blackboard into their notebook. After that she distributed pupils' workbook and instructed them to do some exercises on certain pages. Then after this, she asked everybody to stand up and said that she will asked pupils to give examples of animals as she said the types of movements. Those who answered correctly can sit down. Then teacher asked what conclusion could be made from the lesson. But before pupils can answer teacher give the conclusion instead (here is another event which teacher showed authoritative attitude).

#### Observation description

Teacher's Name: SH

Date: 17/3/99

Time: 12.00-1.00

No of pupils: 38

Topic of lesson: Temperature

Strategy: Practical activity

Approach: Guided inquiry approach

Teacher started the lesson by saying that they will be learning new lesson. But before that she said she wants two pupils to act a scene but they do not have to say anything. Then two pupils came out and acted a scene in a clinic, where a doctor was treating a patient. Other children were asked to watch the act and later asked the pupils what was the act about. Then teacher asked what did the doctor used. Pupils responded by saying, a thermometer and a stethoscope. Then teacher asked what is the use of thermometer. A pupil answered, to measure the body temperature. She explained that the topic of the day lesson is on temperature. Then teacher asked is there anybody who have not seen thermometers but all pupils said they have seen it before. Teacher continued by explaining the types of thermometer and the physical structure of thermometer. Then she told them that they have to know the parts of thermometer because there would be exercise on this later. Then she continued telling them the part of the thermometer and the liquid mercury in the thermometer. After explaining the parts she asked pupils to say out the parts as a class. Then she explained how to read the thermometer. Teacher used a transparency for this purpose. After the explanation, teacher asked pupils to make six groups and started distributing the task sheet to everyone. Then teacher distributed 2 types of thermometer to each group while reminding them to take care of the thermometer. Then teacher asked pupils to refer to the task sheet and read it together with the pupils. Teacher explained briefly what they should do in the practical activity. Then pupils started the activity. At this instant teacher distributed a large sheet of paper for each group to record their observation.

During the activity, it can be seen pupils have difficulty in reading the clinical thermometer and so does the teacher (The teacher asked me for help in reading the clinical thermometer and I helped her). Then she teaches the pupils to read the clinical thermometer. Then she instructed pupils to go to their respective seats as the noise become unbearable. Some pupils said they cannot see the reading but teacher said if they have time, they would do that again. The next activity teacher instructed the leader to get the warm water from the back of the class. Then she instructed pupils to put in the thermometer and record their reading. During the activity teacher monitored pupils work. Then she instructed them to throw away the warm water and replace it with cold water and then instructed them to put in the thermometer and record the reading. (It seemed that teacher instructed the activity step by step with the pupils). After they have finish the activity teacher instructed pupils to keep back thermometer to their places.

Then teacher discussed the result with the pupils after all the leaders have put up their results on the board. Then teacher explained the normal body temperature. Then teacher compared the result of the warm and cold water from each group. She asked which group has the highest temperature for the warm water and which group has the lowest temperature. Then she explained the reasons of the difference of temperature. Then teacher went through the questions in the task sheet together with the pupils. She dictated the answer for the pupils to write in the task sheet. There is a question on hypothesis which teacher asked the pupils. A pupil gives an answer but guided by the teacher. She told other pupils to write as she dictated the answer.

Finally teacher asked pupils to make a conclusion of a lesson. A pupil tried to give his conclusion and teacher helped him to make the correct sentence for the conclusion. Teacher dictated again so that others able to write it down on the task sheet. Finally teacher give another exercise sheet for pupils to do for the remainder time of the lesson.



## APPENDIX 11 Translation of the syllabus of the Primary Science Curriculum

### Introduction

As a nation that is moving towards the status of developed nation, Malaysia has to establish a scientific and progressive society, a society that has the high ability to change and forward looking and the contributors to the scientific and technological civilisation of the future.

To fulfil this aspiration, we have to produce creative and competent citizens that practice the scientific and technological culture. The citizens with the scientific and technological culture will exhibit the characteristics such as curiosity and the drive to try, science literate, open-mindedness, making decision based on real facts and appreciate the contribution of science and technology. These kinds of citizens will only be produced if an early exposure to science and technology is given.

In general, science is view as a field of knowledge and as an inquiry method and problem solving.

As a field of knowledge, science provides a frame of concepts that enable children to understand their surrounding. The science knowledge will be more meaningful to children if they are help to connect the facts and the concepts, making generalisation and to relate the new learning with the prior knowledge. This will enable them to understand the situation and the new information.

As inquiry method and problem solving, science will be able to develop the skills to study their surrounding and besides that they will gained knowledge. Inquiry as scientific process will need and enable children to develop their positive attitude. Science learning will encourage their curiosity, creativity, open-mindedness, perseverance, caring for the living things and appreciating the environment.

Science in the primary school enables pupils to learn about themselves and their environment through experience and investigation.

This science curriculum is legislated for the Phase II of primary science, the Year 4, 5 and 6. Emphasis is given to learning through experience and relevant to their everyday life, inquiry approach, development of the science process skills and thinking skills, investigation and problem solving, application of scientific principals and instilling of the scientific values and noble values.

### Aim and Objectives

Primary science education is aim to produce knowledgeable and skill-full mankind to develop scientific and technological cultured society, caring, dynamic and progressive to be more responsible towards the environment and admire the creation of nature.

The aims of primary science education is achieved by giving the opportunity for pupils to learn through experience to:

- develop thinking skills to increase intellectual capability;
- develop scientific skills in an inquiring manner;
- increase interest towards the environment;
- gain knowledge and understanding of the scientific concepts and facts in order to understand themselves and their environment;
- develop the ability to solve problems and make responsible decisions;
- increase their ability to cope with the latest contributions and innovations in science and technology;
- practice good moral values and scientific attitudes in every day life;
- appreciate the contributions of science and technology for the welfare of our life;
- appreciate the arrangement and orderliness of nature

### Scientific Skills

This science curriculum focuses on the mastery of scientific skills that is needed to investigate and understand nature. In this curriculum, the scientific skills consist of the science process skills and manipulative skills.

The science process skills enable pupils to question something and find the answer systematically. These process skills are made up from easy to complex skills.



In the Primary Science Curriculum, the science process skills to be developed is listed as below:

Observation	Using sight, hearing, touch, feel and smell to collect information about object and phenomenon.
Classification	Group objects based on similar characteristic
Measuring and using numbers	Making observation quantitatively using instruments with the standard units. Measuring will make the observation become more precise. The ability of using numbers is important in acquiring the measuring skill.
Making inference	Making initial conclusion to explain an event or object based on observation. The initial conclusion maybe right or wrong.
Prediction	Making assumption about an event base on previous observation or data that is believed to be true.
Communication	Present ideas in various formats such as verbal, writing, graph, charts, model or tables.
Using space and Time relationship	To explain location, direction, forms and size of an object and it changes according to time
Interpret information	Give rational explanation about objects, events or patterns from the collected information
Define operationally	To give definition about a concept by stating the things that need to be done and observe
Controlling variables	In an investigation, a variable is manipulated to observe the relationship with other variables. At the same time, other variable is made constant.
Making hypothesis	A general statement that is thought as true to explains something or an event. This statement needs to be tested to prove its validity.

The manipulative skills are the psychomotor skills in the science investigation to enable pupils to: -

- use and handle science equipment and material correctly
- keep science equipment and material correctly and safely
- clean science equipment correctly
- handle living and non-living specimens correctly and carefully
- draw specimens, material and equipment precisely

### *Thinking Skills*

Thinking is a mental process that needs the interaction between knowledge; skills and attitude to enable individuals to understand and manipulate nature. The thinking skills can be group into creative and critical thinking. A person that thinks critically always evaluates an idea systematically before accepting it.

A person that thinks creatively has a high imagination ability and use several of approaches to solve problems and able to produce original ideas. The science process skills are a mental process that encourages critical, creative, analytical and systematic thinking. Mastering of science process skills together with attitude and suitable knowledge guaranteed pupils ability to think effectively.

### *Attitude and Values*

The experience in learning science is able to instil the positive attitude and values in pupil. The positive attitude and values in learning science in primary school include the scientific skills and noble values as follows: -

- interest and curious to know about the environment
- honest and accurate in recording and validating data
- flexible and open-minded
- perseverance in carrying out tasks
- systematic and confident
- co-operation
- responsible on self safety and colleagues as well as environment
- caring
- appreciating science and technology contributions
- grateful on God's given things



- appreciating and practising the clean and healthy lifestyle
- aware that science is one of the way to understand nature

### ***Investigation Field***

This science curriculum gives the opportunity for pupils to investigate their environment through five Investigation Field: -

Investigating the Living World

Investigating the Physical World

Investigating the Material World

Investigating Earth and the Universe

Investigating Technological World

### ***Investigating the Living World***

Through this Investigation field, pupils will have opportunity to develop their knowledge and scientific skills and noble values about the living world. Pupils are given opportunity to increase knowledge about various living thing in nature and understand that mankind has speciality that differentiate them from other living things.

Pupils will investigate about the basic needs and life processes of mankind, animal and plants. Besides that, pupils will also investigate the interaction between living things and effect of human activities on other living things together with the attempt to cultivate and conserve.

### ***Investigating the Physical World***

Through this investigation field, pupils will have the opportunity to develop their knowledge and scientific skills and noble values about the physical world. Pupils are given the opportunity to upgrade their understanding about the space and time concepts qualitatively and quantitatively.

Pupils will also investigate natural phenomena such as lights, sound, heat, movement, electric, magnet and energy.

### ***Investigating the Material World***

Through this investigation field, pupils will have the opportunity to develop their knowledge and scientific skills and noble values about the material world. Pupils will be given the opportunity to investigate the properties of the natural material and man-made material. Pupils will be able to use the knowledge on the properties of material and relate it to the everyday use of the material safely. Pupils will also have the opportunity in experiencing how to conserve the material.

### ***Investigating Earth and the Universe***

Through this investigation field, pupils will have the opportunity to develop their knowledge and scientific skills and noble values about the earth and the universe. Pupils are given the opportunity to investigate about earth and its relationship with the Moon, Sun and other planets in the solar system. Besides that pupils will have the opportunity to be thankful on the beauty of the universe.

### ***Investigating Technological World***

Through this investigation field, pupils will have the opportunity to develop their knowledge and scientific skills and noble values about the technological world. Pupils are given the opportunity to investigate the history of technology development and the present technologies use in the agriculture, communication, transport and building. Opportunity is also given to increase pupils' creativity through activities where pupils create a technology using the science principals that have been learnt. Other than that, pupils are given the awareness on the contributions of technology to the welfare of mankind.



## Teaching and Learning Strategies

The teaching and learning strategies suggested in the primary school science subject is based on learning through experience that gives priority to the inquiry approach. Inquiry generally means finding information, questioning and investigating a phenomenon happening in the surrounding.

Discovery is the main attribute of inquiry. Learning through discovery happens when the main concept and principle investigated and found by the pupils themselves. However, for the primary level, pupils need guidance in finding a concept and principle. Thus, the effective approach is through guided discovery. This means teachers guide pupils in discovering a concept and principle through discussion, question or problem solving.

However, it should be remembered that the inquiry approach is not suitable to be use in all teaching and learning situation. Some concepts and principle are suitable to be exposed directly by teachers.

Various methods can be carried out by teachers to teach and guide pupils to gain knowledge, master the scientific skills and practice the noble values in learning science so that they will be more critical, analytical and responsible. The suggested methods include experimenting, discussion, simulation and project.

Experimenting	Testing hypothesis through investigation. Involve pupils to control variable and involve science process skills and manipulative skills
Discussion	Pupils' questions and present opinions based on poof and valid reasons and have open mind to receive opinions of others.
Simulation	The activity carried out is similar to the real situation. Three main examples of simulations are role-play, games and usage of models. In role-play, pupils will act a role spontaneously base on a few rules stated. Games will have rules that need to be followed. Pupils play to learn some principle or to understand the process of making decisions. Models can be used to represent the object or real situation. Pupils' ability to imagine the situation will help them understand the concept and principle learned.
Project	Activity carried out by individuals or groups of pupils to achieved an objective and it takes a long time and sometimes it extends over the formal learning session.

## Evaluation

Evaluation must be carried out continuously to find out how far pupils are able to achieve the stated objective. This can be done through observation, verbal or written. Teachers are to arrange and plan the next action and thus must use information from evaluation. The next action is aim to overcome pupils weaknesses and strengthen pupils learning.

Teachers must record pupils' achievement and keep the evaluation information for every pupil systematically so that pupil's progress will be followed. The product of evaluation must be reported to pupils, parents and other party according to needs and suitability. Feedback from the evaluation by the teachers is important as a guide to the success of the implementation of this program.

Three aspects that need to be evaluated in the teaching and learning of Primary Science Curriculum are:

### Knowledge

The knowledge aspect that need to be evaluated is the pupils' mastery of facts, concepts, principle at all cognitive level that is knowing, understanding, application, analysing and synthesis.

### Skills

The skills aspect that need to be evaluated is pupils' mastery of the scientific skills that is the science process skills and manipulative skills, thinking skills, the creative and critical skills to test pupils ability in problem solving and making decision.



### Attitude and Values

Scientific attitudes and noble values that can be evaluated are pupils practice and internalisation of accuracy, perseverance, co-operation, responsible, caring, systematic, appreciating and grateful attitude, confidence, cleanliness and safety.

Several techniques can be used to evaluate knowledge, skills and attitudes and values. A few evaluation techniques identified include: -

- Multiple choice questions
- Completing sentences
- Short answer questions
- Essay questions
- Formal or informal observations
- Practical exams

Even though all the stated techniques can be used to evaluate knowledge, skills, attitudes and values, certain techniques are the most suitable to evaluate certain aspects.

The following table gives the suitable technique to evaluate the knowledge, skills and values aspects:

TECHNIQUE	KNOWLEDGE	SKILLS	ATTITUDES AND VALUES
Multiple choice question	√	√	
Completing sentences	√		
Short answers questions	√		
Essays questions	√		
Observations		√	√
Practical Test		√	

### Organisation of content

Science knowledge, scientific skills, scientific attitudes and noble values that are included in this curriculum is stated in the form of **Objectives to be achieved** and **Suggestion of learning experience**.

The objectives to be achieved is divided into the **General Objectives** and **Specific Objectives**

The general objective uses the adverb to explain the intended pupils' achievement from the aspects of cognitive, affective and psychomotor, including the scope of the Investigation field.

The specific objective is giving details of the general objectives. It is written in the form of pupils' behaviours that is able to be monitor and evaluate. The specific objective gives the depth of the Investigation Field.

The objective to be achieved legislated for every Investigation Field is distributed to Year 4, 5 and 6 based on pupils cognitive development.

Suggestion of Learning Experience given is to help teachers plan activities that need to be carried out to achieve the Specific Objectives concerned. All planned activities must move towards the development of pupils' scientific skills and thinking skills.

The statements written under the Suggestion of Learning Experience is the activity using the science process skills. The word *investigations* sometimes use to show the activity from collecting information to making conclusion. The easiest investigation activity involves the process skills of observation and making inference. In the higher level, the investigation activity involves a few process skills that lead to the making of inference. Experimenting is the highest level of investigation activity.

Before making any planned activity, pupils need to be given early preparation such as collecting information from several sources.

Teachers may modified the Suggestions of Learning Experience suggested suitable with pupils ability and their surrounding.



## THE PRIMARY SCIENCE CURRICULUM YEAR 4

### Investigating LIVING WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTION OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Know the existence of variety of living things in nature	1.1 Identify the variety of living things existing in nature 1.2 Name the variety of living things existing in nature	Collecting and naming variety of animal and plants existing in the school surrounding, home and nature
2. Understand that physical attribute and characteristics of plants and animals can be used to classify living things	2.1 Identify the physical attributes that can be seen on animals 2.2 Differentiate animals according to the identified physical attributes 2.3 Give examples of attributes that can differentiate animals 2.4 Identify the physical attributes that can be seen on plants 2.5 Differentiate plants according to the identified physical attributes 2.6 Give examples of attributes that can differentiate plants	Observing the physical attributes available on animals Classifying animals according to their physical attributes such as hairs, scales, legs, wings and shells Classifying animal according to attributes such as laying eggs, giving birth, live on lands, live in water and eating habits through discussion Observing the physical attributes available on plants Classifying plants according to their characteristics such as giving out seeds or spores live on land and live in water, through discussion
3. Understand that animals and plants have basic need to live	3.1 Explain the basic need for animals and plants to live	Carrying out experiment to determine the basic need of plants such as water, sunlight and air. Observing animals habits and make inference on their basic needs
4. Understand that human being, animals and plants go through a number of processes to live.	4.1 Explain the ways of breathing for human being, animals and plants. 4.2 Generalise that animals eat different type of food. 4.3 Explain the growth process of seedling form the height aspect; increase number of leaves and girth of the stem. 4.4 Making inference that human beings and animals go through excretion and dispose the unwanted material to keep good health 4.5 Stating that animal breed by laying eggs or giving birth. 4.6 Give examples of animals that lay eggs and give birth 4.7 Stating that plants reproduce through seedlings, spores, stems or leaves  4.8 Explaining the various ways of animals movement  4.9 Stating the aim of animal movements  4.10 Explaining the various ways plants response toward stimulation. 4.11 Explaining the special attributes on certain animals and plants to protect them from enemies and weather	Observe the ways human, fish and insects breathe. Observe leaves immerse in luke warm water and make an inference on the process. Classify animals according to types of food eaten using picture cards. Plant, observe and record the growth of seedlings.  Discuss the effect of health if the unwanted material in the body is not excreted.  Recording and arranging information about animals breeding by laying eggs or giving birth through scrap books and charts  Recording and arranging information about plants through scrap books or charts Carrying out project on animals and plants breeding. Carrying out simulation on the various ways animal move such as walking, crawling, running, flying, jumping and etc. Carrying out discussion about several aims of animal movements. Carrying out experiment to investigate plants responses towards sunlight, water and touch Recording and arranging information about the special attributes on animals and plants to protect them from enemies and weather through scrapbook and charts.



Investigating  
PHYSICAL WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTION OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Understand that distant is the measurement of length between two points	1.1 Explain the distant concept 1.2 Measuring the straight distant between two point accurately	Measuring distant using: (a) One unit of standard length such as spans pencils and books. (b) Ruler (cm unit)
2. Understand the area is the broadness of an area	2.1 explain the concept of area 2.2 measuring area of a surface	Measuring the area of rectangle or square using: (a) A unit of area of a square that is standard. (b) A unit of area measuring $1\text{ cm}^2$
3. Understand volume is the wideness of a space	3.1 measure the volume of a cube 3.2 measure the volume of liquid 3.3 Explain the volume concept	Measuring volume of an empty box using a unit of volume of standard a cube Measuring the volume of liquid using a measuring cylinder (unit $\text{cm}^3$ )
4. Understand the time concept as the duration between two moments	4.1 Explain that time is measured based on event that is occurring repeatedly in a standard way. 4.2 measure time using clock/watches	Identifying events such as drops of water, swing of pendulum and the bounce of a ball.  Walking from front of classroom to the back using (a) counts of drops of water or swing of a pendulum (b) using stop watch
5. Understand that object has weight	5.1 measure the weight of an object	Measuring the weight of object using a weighing balance <i>Note: At this level, kilogram can be used as a unit of weight</i>
6. Know the attributes of magnet	6.1 Explain the attraction of magnet towards some material 6.2 Explain the attraction and repel between two magnets	Investigating the magnet action on several objects such as pins, nails and paperclips Observing the action between two magnets

Investigating  
MATERIAL WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTION OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Know that objects are made from natural material and man-made material	1.1 Identify the natural material and man-made material 1.2 Identify the natural material used to make the object  1.3 Identify the primary source of the object  1.4 Identify the man-made material from objects	Observing and listing the objects from the surrounding made from natural material and man-made material Grouping and making tables of the objects made from natural material according to types such as wood, soil, rubber, metal, leather, cotton, silk and furs. Observing several objects to identify its primary source, whether plants, animals or rocks. Grouping and making tables of the objects made from man-made material according to types such as plastic and synthetic cloth.
2. Appreciating the existence of various material in nature	2.1 Explain life without the existing of various material in nature	Carrying out a simulation about the importance of various materials in nature.
3. Application of the knowledge on the physical attribute of material and it's usage	3.1 State the physical attributes of material from the aspects of elasticity, floats ,shines and ability to absorb water  3.2 Relating the physical attributes of material with its usage	Investigating the material attributes from the aspects of elasticity floats shines and ability to absorb water. Examples of material; plastic, metal, wood, clothe and paper. Making inference about the usage of material based on their physical attribute through discussion.



Investigating  
EARTH AND THE UNIVERSE

THE OBJECTIVE TO BE ACHIEVED		SUGGESTION OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Know the shape, size and gravity pull of the Earth	<p>State the earth is spherical in shape</p> <p>1.2 Explain the size of the earth from its circumference</p> <p>1.3 State the existence of the earth gravity.</p>	<p>Investigate shape of the earth with looking at a globe or ball through a rolled paper from short distant(approximately 30 cm) and from long distant( approximately 15m)</p> <p>Observing a photograph of Earth taken from outer space or the moon and discuss the shape of the earth.</p> <p>Imagining the size of the earth by comparing the circumference of the earth with an object, for example: If all the Proton cars in Malaysia is arrange in a line surrounding the earth, only a small part of the earth surface is covered.</p> <p>Observing objects falling downwards and make inference about the existent of earth gravity</p>
2. Know about the surface of the earth	2.1 Explain the surface of the earth made up of land, ocean and atmosphere	Observing and identifying the land and ocean on the surface of the earth using physical globe, and atmosphere using video, slide or charts
3. Know about shape and size of sun	<p>3.1 State that the sun is spherical in shape</p> <p>3.2 Explain the size of the sun by comparison with the size of the earth</p>	<p>Observing the shape of the sun during dusk or the image of the sun in a basin of water at other time</p> <p><u>Warning:</u></p> <p><i>Do not look directly at the sun with naked eye.</i></p> <p>Making comparison of the size of the sun and earth.</p> <p>E.g.: Fill in sago represents the earth into a coconut husk representing the sun.</p>
4. Know that the sun radiate heat and light.	4.1 Explain that the sun give out heat and light	<p>Investigating whether the sun give out heat and light</p> <p>Picture and explain the surrounding if there is no sunlight by drawing, essay or role-play</p>
5. Know the shape, size and situation on the surface of the moon	<p>5.1 State the moon is spherical in shape</p> <p>5.2 Explain the size of the moon compared to the size of the earth</p> <p>5.3 Explain the situation on the moon's surface</p>	<p>Observing full moon using charts, picture, slide or video</p> <p>Carrying out a simulation to compare the size of the moon and the earth by using football to represent the earth and a table tennis ball to represent the moon</p> <p>Observing the surface of full moon using charts, picture, slide and video</p> <p>Carrying out the simulation a trip to the moon explaining the situation on the moon such as crater, mountain, soil and rocks</p>
6. Know the distant of the moon from earth	6.1 State the distant of the moon from earth by comparison	<p>Picture the distant of the moon from earth by comparison</p> <p>Example:</p> <p>(a) if a car is able to reach the moon, it will take about 160 days</p> <p>(b) An Apollo rocket will take 4 days to reach the moon</p>

Investigating  
TECHNOLOGICAL WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Know that technology is a way mankind overcome their limitations	<p>1.1 List several things that can and cannot be done by human brain, body and senses</p> <p>1.2 Identify several instruments that can be used to overcome the limitations of the brain, body and senses</p> <p>1.3 State the meaning of technology</p> <p>1.4 List several instrument created by technology in the surrounding</p>	<p>Testing the capability of the brain, body and senses and identify the instruments that can be use to overcome the limitations of the capability, e.g.</p> <p>(a) Recall something such as a phone number of a friend and recalling phone number of five friends without noting it.</p> <p>(b) Jump as high as they can to touch the ceiling</p> <p>(c) Reading the same size of writing from a short distant and a long distant</p> <p>Observing and identifying instrument created by technology in the surrounding such as stationery, calculator, communication instruments, kitchen gadgets, games and transport</p>
2. Understand the history of technological development in the transportation, communication, agriculture and building	<p>2.1 Give examples of types of transportation, communication device, agricultural instrument and types of building</p> <p>2.2 Explain the development of technological history in transportation, communication, agricultural and building</p>	<p>Recording and arranging information about types of transportation, communication device, agricultural instrument and types of building through scrap books</p> <p>Telling story about the development history of technology in transportation, communication, agricultural and buildings</p>
3. Appreciate the contribution of inventor in the transportation, communication, agricultural and buildings	Explain the effort done by inventors in the transportation, communication, agricultural and buildings	<p>Recording and arranging information about the efforts done by inventors in essay form.</p> <p>Note: Inventors include individuals or groups from local or foreign institutions.</p>

PRIMARY SCIENCE CURRICULUM YEAR 5

Investigating  
LIVING WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTION OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Understand ways animals and plants do to make sure the species survival	<p>1.1 Explain the ways animal make sure the survival of their siblings</p> <p>1.2 Explain the ways plants spread their seed to make sure the survival of the seedlings</p>	<p>Observing ways animals care and protect their eggs and siblings whether in real situation or by watching video, slide and charts.</p> <p>Observing the ways plants spread seeds through real situation, video, slide and charts.</p>
2. Understand that food chain as food relationship between living things	Give examples of several food chain	Developing several food chain
3. Synthesise several food chain to form food web	3.1 Group several food chain to form food web	<p>Investigating a few habitat of living things to enable pupils to develop food chain and food web</p> <p>Modifying lyric of a song to picture the real food chain</p>



Investigating  
PHYSICAL WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Know that electric current flow in a complete circuit	1.1 Explain a complete electric circuit 1.2 Draw and label the diagram of complete circuit 1.3 State the function of a switch in a circuit 1.4 Identify material that can conduct electric (conductor) and cannot conduct electric (insulator)	Investigating ways to light the bulb connected with wire and battery Installing a complete circuit based on the complete circuit diagram Investigating the function of a switch in electric circuit Investigating whether material like nails, paper, straw, rope, coins, water, lime, salt water, vinegar and soy sauce able to conduct electric
2. Understand several source of electric energy	2.1 Give examples of sources of electric energy	Investigating several source of electric energy such as batteries, accumulator, dynamo and solar cell
3. Understand that electric energy can be change to other form of energy	3.1 Make Inference that electric energy can be change to light and heat energy 3.2 Explain that the flow of electric current bring the heat effect 3.3 Give examples of electric appliances using heat effect	Observing a lighted Carrying out experiment to investigate the flow of electric current through nichrome wire Observe various electric appliances using heat effect
4. Understand the effect of heat energy	4.1 Explain that material will be heated when heat is supply 4.2 Explain the expansion and contraction of material when heated and cool	Observing an object will be heated when heat energy is supplied. Observation of material expansion when heated and contract when cool
5. Understand that temperature shows the degree of warmth.	5.1 State that a material is hot or cold depends on the temperature of the material 5.2 Explain the losing heat cause the decline of temperature and increase of heat cause the increase in temperature 5.3 Measure temperature accurately using thermometer	Measuring and recording the water temperature when it is being warm or cool using thermometer  Making inference about the relationship between change of temperature with the increase or decrease of heat.
6. Understand the attributes of light	6.1 State that light move in a straight line 6.2 Explain that light can be reflected  6.3 Explain that light is refracted when moving from one medium into another 6.4 State that sunlight made up of seven colour 6.5 List seven colours available in the sunlight spectrum according to order	Investigating the movement of light Observing light reflection by a shiny and smooth hard surface Observing light refraction using medium such as glass and water Observing the colour strips in the spectrum
7. Understand that light can pass through certain material	7.1 Differentiate the material base on the characteristics; transparent, translucent and opaque 7.2 Explain the formation of shadows of opaque material	Investigate various material based on the abilities of light to pass through the material.  Observe shapes and sizes of shadows formed by opaque materials.
8. Understand that sound is produced by vibration	8.1 Explain several ways to produce vibration ; 8.2 Make inference that sound is produced by vibration	Investigating several ways to produce vibration like blowing, knocking and shaking and making inference that sound is produced by vibration

Investigating  
MATERIAL WORLD

1. Know that material exist in the form of solid, liquid and gaseous	1.1 State that material can exist in the form of solid, liquid, and gaseous 1.2 State that solid has permanent shape  1.3 State that liquid that the form of it's container  1.4 State that gas has weight and fill up space	Observing and identify that solid, liquid and gaseous material are available in nature Observe various solid forms and make inference that solid has permanent shape Observing liquid in several container and making inference that liquid taking the form of the container it is filled with. Carrying out experiment to determine whether air fill up space Carrying out experiment to determine whether air has weight by using two
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		similar balloon fill with air
2. Understand that changes of material when heated or cool	2.1 Explain the phenomenon of melting ice, boiling of water, vaporisation of water, evaporation of water, freezing of water and condensation of water vapour.  2.2 measuring water boiling point and melting point of ice	Investigating the following phenomenon: (a) Ice melting in a see through container (b) Boiling and vaporisation of water when heated until boiling (c) Evaporation of water when exposed (d) freezing of water when freeze (e) condensation of water vapour
3. Apply the knowledge on changes in water to formation of clouds and rain	3.1 Interconnect the phenomenon of changes in water with the formation of clouds and rain	Observing the formation of cloud and rain through simulation.
4. Understanding that material has different chemical attributes	4.1 Differentiate various food according to taste (salty, sour, sweet, bitter and tasteless) 4.2 Make inference about attributes such as acidic, alkaline and neutral for food and household material	Testing the food by tasting  Testing food material and household material using litmus paper
5. Know that certain material can become rusty	5.1 Name material that can rust 5.2 Stating that rusting is caused by air and water	Investigating material that can rust Carrying out experiment to investigate factors that cause rusting.
6. Apply knowledge about factors that cause iron rust to prevent rusting	6.1 Making hypothesis how to avoid rusting	Testing hypothesis on ways to avoid material from rusting.
7. Appreciate the importance attempt to avoid iron rusting	7.1 Explain the advantages of avoiding iron from rusting	Recording and arranging information about the advantages avoiding iron from rusting through making poster , create a song or essays.

Investigating  
EARTH AND THE UNIVERSE

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Understand the nature phenomenon is the product of the condition existed on earth	1.1 Naming the layers of the earth 1.2 Explain the temperature and the condition of the earth's layer 1.3 Explain the formation of hot spring, explosion of volcano and earth quake	Draw and label the earth's layer through the building of a model or charts  Observing the hot spring, explosion of volcano and earth quake using charts, slide or video
2. Know the phenomenon of day and night	2.1 State that earth rotate on its axis from west to east   2.2 Explain the happening of day and night	Investigating the earth rotation by recording the changes of measurement and position of shadow of an object from time to time Carrying out a simulation of earth rotation by rotating the globe from west to east that has been put with a match stick in a ray of torch light beam Carrying out a simulation to observe the happening of day and night by giving a ray of light towards a rotating ball or globe
3. Know the phenomenon of moon phases	3.1 State that the moon has no light of it's own 3.2 State that the moon reflect the light of the sun 3.3 Explain that the moon moves around the earth and at the same time the earth and the moon moves around the sun 3.4 Explain the phenomenon of moon phases in a complete cycle	Carrying out a simulation to observe the moon reflecting the Sun's light using model of earth, moon and sun  Carrying out a simulation the movement of earth and moon surrounding the sun Carrying out a simulation to observe the moon phases by using a table tennis ball that is give a beam from torchlight. Carrying out a project to observe and record the moon phase in a month.
4. Grateful for the beauty of the night that brightens up by the moon's beam	4.1 Explain the beauty of the night during full moon	Writing essays, poem or song about the moon



Investigating  
TECHNOLOGICAL WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Understand that strength and stability of a structure depend on the shape.	1.1 Differentiate shape that is available in a structure of construction  1.2 Generalise that strength and stability depends on the shapes	Observing structure of various construction to identify the shape used such as, cubed, sphere, pyramid, cone and cylinder Testing the strength and stability of various simple structure made and the various shape of tower
2. Synthesise the idea about the shape to construct a strong and stable structure	2.1 Create a model of a structure that is strong and stable	Constructing a model of a structure that is strong and stable base on various shape

PRIMARY SCIENCE CURRICULUM YEAR 6

Investigating  
LIVING WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Understand that competition as a form of interaction between living things	1.1 Explain the competition as a form of interaction between living things in an environment with limited sources	Carrying out experiment to investigate the competition between seedlings
2. Understand that mankind is trusted to handle the living world with responsibility	2.1 Explain the importance for mankind to conserve plants and animals	Recording and arranging information about the extinction of animals and plants and the efforts on conservation through discussion
3. Thankful that mankind is the best form of living things	3.1 State the speciality of mankind that differentiate them from other living things	Writing essays or poem on the speciality of mankind

Investigating  
PHYSICAL WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Know the forces and their effects	1.1 Explain that pushing and pulling are forces  1.2 Explain that force cause changes of shape of an object 1.3 Explain that force cause the change of movement in an object  1.4 Explain the friction force on the moving object	Experience the force effect by pushing the palms by a pair of pupils and pulling also by pair Investigate the act of force on changes of shape of an object Observing the action of the changes in movement and direction of an object such as, a static ball, a moving ball, a ball moving in opposite direction and a rotating glob Observing the movement of object on several types of surfaces and making inference on the existent of friction.
2. Understand that moving object has acceleration	2.1 Make inference that object that move fast will move further in a specific time, or object that move fast will take shorter time to move to a specific distant. 2.2 Determine the acceleration of a moving object	Measuring and comparing the distant taken by two objects moving in a specific unit of time Measuring the time taken by two object moving in a specific distant Calculating the acceleration of a moving object in a specific distant

Investigating  
MATERIAL WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Understand the ways to preserve food	1.1 State that food will be spoiled by bacteria and fungus 1.2 Explain the ways to preserve food	Observing and recording the growth of fungus on bread  Carrying out a project in preserving food such as drying, freezing, salting and pickle. Recording and arranging information about the steps in food canning and bottling through charts and drawing
2. Understand the effect on waste disposal to environment	2.1 Explain that the disposal of waste unsystematically will cause pollution	Recording and arranging information about the unsystematic waste disposal through scrap book
3. Know that the waste can be recycle	3.1 Explain the way to recycle paper 3.2 State that the dispose material can be used again	Carrying out activity that produce paper from used papers Carrying out discussion to identify materials that can be recycle
4. Appreciate the importance of recycling of waste material	4.1 State the advantage of recycling the waste material	Carrying out a debate or writing essay on the advantage of recycling to conserve the nature

Investigating  
EARTH AND THE UNIVERSE

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Understand the phenomenon of moon's eclipse and sun's eclipse	1.1 Explain the phenomenon of moon's eclipse 1.2 Explain the phenomenon of sun's eclipse	Carrying out a simulation to observe the eclipse of the moon by using the models of Sun, Moon and Earth Drawing the diagram of the eclipse Carrying out simulation to observe the sun's eclipse by using the models of the sun, moon and earth Drawing the diagram of the eclipse
2. Know the solar system	2.1 Name the planets in the solar system according to the order from the sun 2.2 State that planets are rotating and at the same time move surrounding around the sun 2.3 State the asteroid and meteor are part of the solar system	Carrying out a project in making model of solar system  Carrying out the simulation to observe the rotation and movement of the planet around the sun using model, or role-play Observing asteroid and meteor using charts and slide
3. Know about the constellation	3.1 State the constellation is a group of stars seen to form certain pattern 3.2 Identify the constellation that is easily seen 3.3 State that constellation helps in determining bearing	Identifying certain pattern of constellation by connecting dots on diagram Observing constellation in the sky at certain time to connect it with the pattern
4. Admire the beauty of the universe created by God	4.1 Explain the beauty of the universe	Writing poem and essays about the beauty of the universe

Investigating  
TECHNOLOGICAL WORLD

OBJECTIVE TO BE ACHIEVED		SUGGESTIONS OF LEARNING EXPERIENCE
GENERAL OBJECTIVE	SPECIFIC OBJECTIVE	
1. Analyse simple machine from it's function	1.1 Identify the simple machine such as wheel and axle, pulley, screw and gear 1.2 Draw and label the simple machine 1.3 Identify the situation using simple machine to make works easier for man. 1.4 Identify simple machine in certain complex machine	Observing several appliances and model such as toy crane, bottle opener, and corkscrew, to identify the principle of simple machine used. Investigating a situation using the principle of simple machine such as pulling up a flag, pushing object on the slope, cutting wood and playing with roller shoes.



		Investigating several complex machine such as clock, bicycle, push chairs that contain a few simple machine
2. Synthesise ideas about simple machine to create a tool	2.1 Create a model using simple machine	Identifying problems, planning and building models using simple machine

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